From Ecosystem Services to Ecosystem Benefits:

Unpacking the Links Between Ecosystems and Human Well-Being in Agricultural Communities in Costa Rica

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ABSTRACT

This dissertation presents an exploration of the links between ecosystem services and human well-being in resource-dependent communities in diverse agricultural regions in Costa Rica. As such, this dissertation considers the key roles played by environmental management and environmental governance. In broad terms, the question that this dissertation examines is: How does the management of ecosystem services derived from agriculture impact human well-being in resource-dependent communities in Costa Rica? This dissertation has taken as a point of departure the framework proposed by the Millennium Ecosystem Assessment (2003, 2005) and has applied it to the examination of communities that are particularly vulnerable to environmental change. The focus on well-being brings to the forefront questions about the distribution of the benefits derived from ecosystems and highlights the perceptions of ecosystem-users. Three manuscripts make up this dissertation: The first manuscript uses a participatory method (photovoice) to elicit narratives about the ecosystems that impact the well-being of residents in the pineapple community of Volcán de Buenos Aires in South-Pacific Costa Rica. The manuscript offers a community-level perspective on the ecosystem services that contribute to the well-being of agricultural communities. The second manuscript focuses on how access and power relations affect the benefits experienced by Indigenous farmers in the Bribri Territory who produce plantains for sale in the national and international markets. The manuscript identifies how access to the means of production is gained, controlled and maintained within the social-ecological system of plantain agriculture. It also identifies the mechanisms that gatekeepers employ to exercise their power. The manuscript concludes with possible leverage points that could be used to challenge existing power relations and improve human well-being in the Bribri Indigenous Territory. The third manuscript presents three

community-level assessments of well-being from agricultural regions on the Caribbean side of Costa Rica that have different environmental management systems ranging from large-scale monocrop banana plantations in Matina to agroforestry in the Bribri Indigenous Territory. The analysis investigates the ways in which different systems of resource extraction shape well-being at the local level. In brief, the dissertation offers insights for improving the theoretical and empirical understandings of how changes in ecosystems affect human well-being in resource-dependent communities. It also offers suggestions to render the ecosystem services framework more relevant to guide environmental management at the micro-scale and in the context of poverty alleviation.

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1. ECOSYSTEMS AND HUMAN WELL-BEING

Figure 1-1. Photograph taken during a workshop on ecosystem services in Volcán de Buenos Aires (Costa Rica). Source: Author.

The last of sunlight was fading away in the manner that days end in the tropics, without warning or preamble. I stood in the church hall with a picture of a nuclear family that I had painted the night before and asked, *"What does this family need to live well?"* In front of me, a group of curious ranchers, plantation workers, housewives and kids shouted out answers, timidly at first, *"Electricity", "A house",* and then with more assertiveness *"God!" "They need shoes!"* I wrote their answers in pieces of paper that I hung on the wall and then I turned around once again to ask: *"And how does nature provide for these needs?"* That was the beginning of a workshop on ecosystem services in Volcán de Buenos Aires (Figure 1-1) a small community surrounded by pineapple fields in South-western Costa Rica. It was also the

beginning of the process of inquiry contained in this dissertation, which focuses on understanding the ways by which human well-being in resource-dependent communities in the global South can be improved. More specifically, the motivation behind this research emerges from a fascination with the dynamic relationship between ecosystems and human well-being, which forcefully highlights the need to examine the broader themes of environmental management and environmental governance.

The Millennium Ecosystem Assessment (MEA) is a useful departing point as it offers a framework to begin to interrogate the interactions between the three pillars that support this dissertation, that is, between ecosystem services, human well-being and environmental management. The MEA was an initiative launched by the United Nations in 2003 involving hundreds of scientists internationally to evaluate the state of the world's ecosystems. The MEA defined ecosystem services as "the benefits people obtain from ecosystems" (MEA, 2003, p.3) and classified them into four categories: provisioning ecosystem services are associated with the supply of material goods (e.g. crops, timber, fish, fuel); regulating ecosystem services are associated with the regulation of natural processes (e.g. climate regulation, pest control, soil erosion prevention); cultural ecosystem services refer to the nonmaterial benefits that humans might derive from their natural surroundings (e.g. recreational use, spiritual fulfillment, bequest value); and, supporting ecosystem services are the underlying services that sustain all of the others (e.g. nutrient cycling). The MEA (2003) also provided a definition for human well-being as a multidimensional concept that depends on having the basic materials for a good life, feeling safe, being in good health, having meaningful social relations and enjoying freedom of choice. It is understood that freedom of choice depends on having fulfilled to some extent all of the other dimensions.

The main conclusions following the MEA (2005) were: First, that in the period between 1950 and 2000 humans modified ecosystems more extensively and more rapidly than in any other equivalent period in history. Second, that the modification of ecosystems resulted in significant gains in human well-being, but clearly at a cost. In particular, the MEA found that the majority of the earth's ecosystem services were in decline, with the exception of crops, livestock and aquaculture, which suggests a trade-off between different kinds of ecosystem services (Raudsepp-Hearne et al., 2010) (see Table 1-1). Third, that the continued deterioration of ecosystems will become an impediment to the fulfillment of the Millennium Development Goals. Fourth, that despite the bleak picture, there were workable solutions to reverse the downwards trend, although implementing these would require changes in environmental governance at a much larger scale than we are currently witnessing.

Summary of the Trends Regarding the State of the World's Ecosystem Services. Source: MEA (2005)

Table 0-1 Summary of the Trends Regarding the State of the World's Ecosystem Services. Source: MEA (2005)

	Degraded	**Mixed**	**Enhanced**
Provisioning services	Captured fisheries Wild plant and animal products Freshwater Natural medicines and pharmaceuticals		Crops Livestock Aquaculture Timber
Regulating services	Air quality regulation Regional climate regulation Erosion regulation Water purification and waste treatment Pest regulation Pollination Natural hazard regulation	Water regulation Disease regulation	Global climate regulation
Cultural services	Spiritual and religious values Aesthetic values	Recreation and ecotourism	

Two aspects of the framework proposed by the MEA make it a good diving board for this dissertation: First, the concept of ecosystem services that is proposed by the MEA makes explicit the link between the fulfilment of human needs and the functions of ecosystems (see figure 1-2). This provides a base to begin to analyze well-being in small agricultural

communities in the South where livelihoods are shaped largely by the production of provisioning ecosystem services. Indeed, the communities examined in this dissertation can be characterized as resource-dependent communities that rely primarily on a single, or a reduced range, of ecosystem services for their livelihoods. This circumstance makes resource-dependent communities especially vulnerable to environmental change and surprise (Adger, 2000). Thus, to understand the mechanisms that foster and improve human well-being in this context, it is important to consider environmental management and, more broadly, environmental governance. I define environmental management as the set of practices regulating the interactions between humans and their ecosystems, and environmental governance as the multi-scale processes and mechanisms by which social actors (including the state, communities, NGOs, businesses or partnerships among these) influence environmental actions and outcomes. Second, while the MEA makes the link between ecosystems and human well-being explicit, it also remains vague in terms of specifying what the arrows that link ecosystem services with the different dimensions of human well-being in figure 1-2 actually mean. In other words, the MEA framework conveys that, at a very basic level, human survival on earth depends on the continued flow of goods and services from the planet's biomes. Yet, the reality is that humans do not simply aspire to survive; instead, humans lead complex lives in which a variety of factors contribute to their well-being, many of which might have only a distant or indirect connection to ecosystem functions (Butler & Oluoch-Kosura, 2006). So, on the one hand, the MEA has been decisive in mainstreaming the concept of ecosystem services, which provides a common ground for addressing economic, social and environmental concerns in resource management. On the other hand, there is still a need to further unpack the idea of ecosystem services to better understand how changes in ecosystems impact human well-being,

particularly the well-being of vulnerable populations (Balmford & Bond, 2005; Carpenter et al., 2009; Daw et al., 2011).

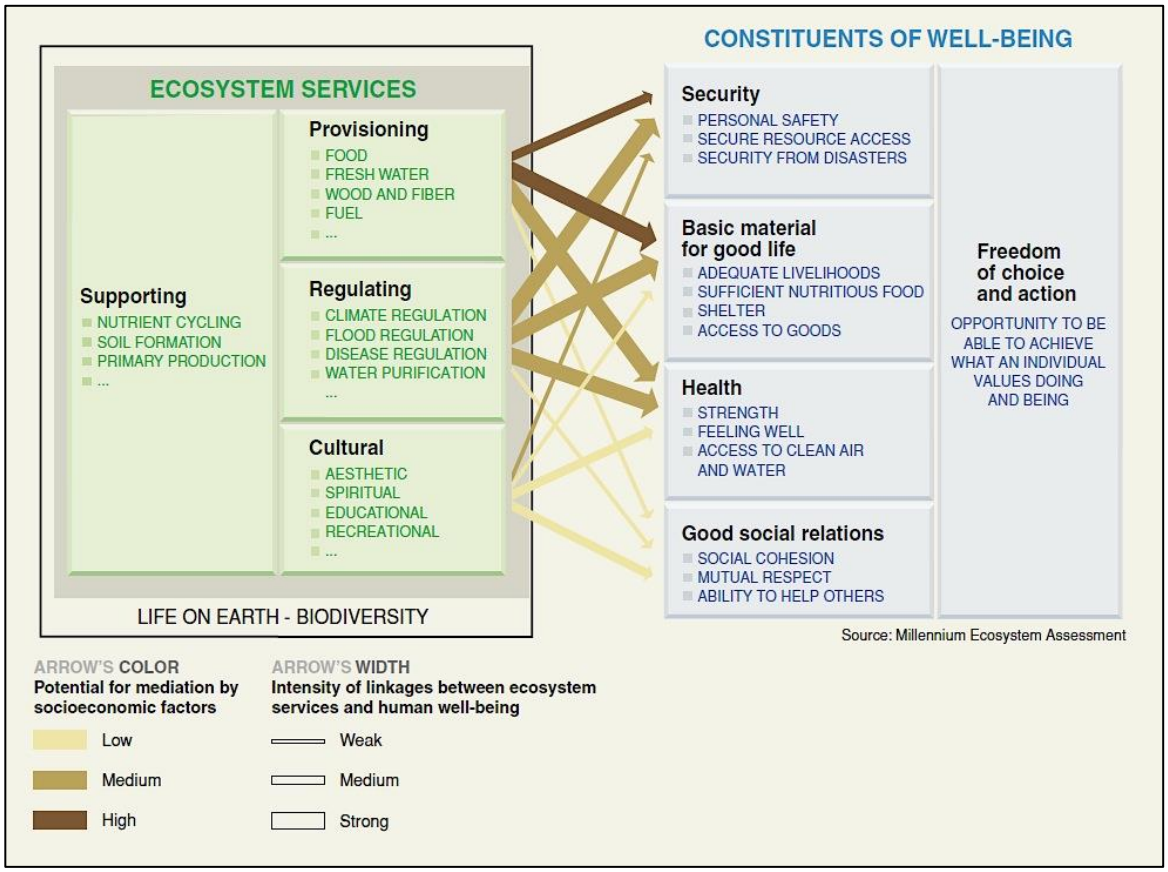

Figure 1-2. Framework from the MEA connecting ecosystem services with different dimensions of human well-being. Source: MEA (2003).

Motivated by the need to improve the theoretical and empirical understandings of how changes in nature affect well-being and livelihoods in resource-dependent communities, the question that my research explores is: *How does the management of ecosystem services from agricultural landscapes impact human well-being in resource-dependent communities in Costa Rica?* To answer, I looked for alternatives to the way that ecosystem services are normally studied. That is, instead of focusing on the supply side of ecosystem services, I started from the point of view of what is necessary for humans to flourish, thus bringing to the forefront questions about the distribution of the benefits derived from ecosystems and highlighting the

perceptions of ecosystem-users. Ultimately, I argue that not only do environmental management priorities shape the patterns of ecosystem services bundles associated with different forms of agriculture (Foley et al., 2005; Bennett & Balvanera, 2007), they also shape the dimensions of human well-being experienced by those living in agricultural communities, given that these are coupled social-ecological systems.

Sketch of Agriculture in Costa Rica

Historically agriculture has been the backbone of the Costa Rican economy, although its importance has been diminishing in favour of the manufacturing, services and tourism sectors. Today, Costa Rica contains a variety of agricultural modes of exploitation reflecting differences in management cultures, as well as a diversity of historical, social, economic, and ecological factors. In this dissertation I considered three agricultural regions with distinct systems of ecosystem exploitation used to produce bananas, pineapples and plantains. The research sites include communities surrounded by pineapple plantations in the county of Buenos Aires (Puntarenas province) on the South-Pacific coast; communities surrounded by banana plantations in the county of Matina (Limón province) towards the middle of the Atlantic coast; and communities that produce plantains, bananas and other crops in smallholdings in the Bribri Indigenous Territory in the county of Talamanca (Limón province) on the South-Atlantic coast (see Figure 1-3).

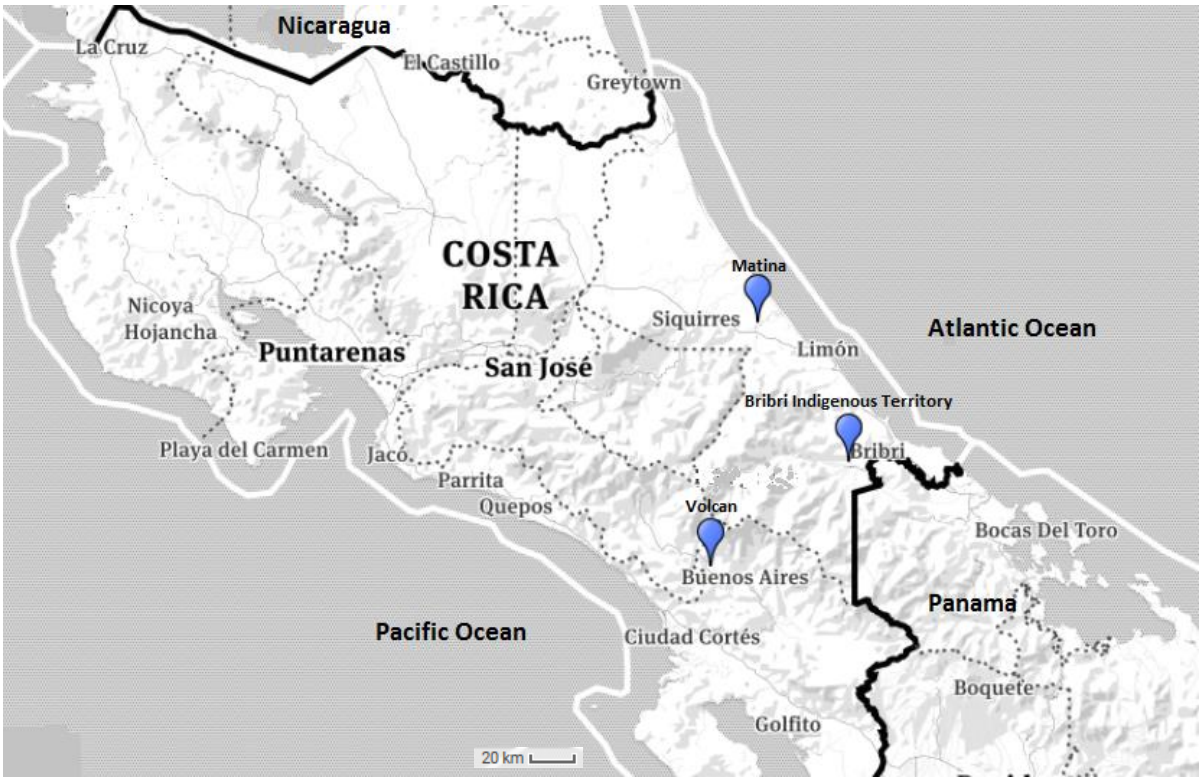

Figure 1-3. Location of the three research sites: Volcán de Buenos Aires (Puntarenas), Matina (Limón) and the Bribri Indigenous Territory (Limón).

The lack of precious metals in Costa Rica meant that for most of the colonial period the country remained a relatively poor and sparsely populated province of the Captaincy General of Guatemala. After independence in 1821, Costa Rica began to ramp up its agricultural crop production for the international market as a way of developing its economic base. Although Costa Rica began by exporting tobacco, it was coffee from the Central Valley, with its combination of climate, altitude and fertile volcanic soils, that catapulted Costa Rica as a player in the global commodity trade (Samper, 1993; Perez-Brignoli, 1997). From this point on the economy of the country became closely linked to the fluctuations of the prices of commodity exports. In 2013, agricultural activity contributed 5.1 percent of the country's gross national product employing 13 percent of the labour force and occupying approximately 10 percent of

the land surface area (SEPSA, 2014). In that same year, the top agricultural commodities for export were bananas, pineapples and coffee destined primarily to the United States and Europe (SEPSA, 2014). While agriculture generates a substantial amount of Costa Rica's foreign exchange, the main agricultural areas continue to be poor relative to the rest of the country, especially when compared to the standard of living in the Central Valley region that includes the capital city of San Jose. For instance, while in 2012 Costa Rica's Human Development Index (HDI) was 0.773, the HDI of the county of Buenos Aires was 0.654, Matina's was 0.613 and Talamanca's was 0.611, ranking 78th, 79th and 80th out of 81 counties respectively (PNUD, 2011). Table 1-2 displays additional indicators of human well-being for the three research areas. Below I describe each research site in turn (note that similar information to the descriptions of research sites are also contained in the individual manuscripts).

Table 1-2.

Selected Indicators of Human Well-Being for the Counties of Buenos Aires, Matina and Talamanca, Where the Research Communities are Located. Numbers in Brackets Indicate the County's Ranking out of a Total of 81 Counties. Source: PNUD, 2011.

	Buenos Aires	**Matina**	**Talamanca**
Human Development Index	0.654 (78th)	0.613 (79th)	0.611 (80th)
Life Expectancy Index	0.853 (43rd)	0.871 (31st)	0.789 (71st)
Life Expectancy	79.8	80.5	77.6
Knowledge Index	0.760 (69th)	0.688 (78th)	0.673 (80th)
Primary School Enrolment	100%	100%	100%
Secondary School Enrolment	64.2%	46.9%	56.2%
Adult Literacy	90.9%	93.1%	83.7%
Material Well-being Index	0.350 (78th)	0.280 (81st)	0.370 (77th)
Human Development Relative to Gender	0.628 (78th)	0.591 (79th)	0.578 (80th)
Gender Empowerment Index	0.746 (63rd)	0.695 (77th)	0.728 (71st)

Matina: The Legacy of the Banana Republic

The advent of the coffee boom that began in the 1830s brought the need to develop better transportation routes connecting the Central Valley to the coast. At the offset, coffee was exported via the port of Puntarenas on the Pacific coast, but eventually the construction of a

new port on the Atlantic was deemed necessary. Thus, in the late 1800s the Costa Rican government undertook the construction of the Atlantic Railroad, opening up access to the Caribbean coast of Costa Rica, which had remained relatively isolated from the economic growth experienced in the Central Valley due to geographical factors. Prior to the construction of the railroad, the predominant crop grown in the Atlantic region was cacao beans produced in smallholdings, which hardly ever found a stable market. However, the small-scale agricultural character of the region would change drastically once the Costa Rican government, plagued with problems and delays, handed over the contract for the construction of the Atlantic Railroad to North American entrepreneur Minor C. Keith. Along with the contract Keith obtained generous concessions of lands alongside the railroad. These concessions encompassed a sizeable portion of the province of Limón including the alluvial plains of major river systems. Keith launched the first commercial banana operation out of the Zent River valley in 1872, eventually creating the United Fruit Company (UFCO) in 1899. Three factors were determining in giving rise to this pioneer of modern agri-business: First, the combination of temperature, precipitation and soil in the Caribbean coast of Costa Rica is ideal for producing bananas at large scale. In particular, rivers such as the Reventazón, Pacuare, Matina or Zent, descend from the Talamanca mountain range towards the ocean, gathering mineral-rich sediment that is deposited on the floodplains spreading below 500 meters above sea level (Hernandez and Witter, 1996). Second, there was an excess of cheap labour that had been brought to the country previously for the construction of the railway. Third, these workers came predominantly from Jamaica and the West Indies and had prior knowledge and experience tending bananas (Marquardt, 2001).

Figure 1-4. A worker passes by a banana plantation near the community of Matina (Limón). Source: Author.

In my research I focused on banana communities in the county of Matina (Limón) (see figure 1-4). The county of Matina occupies an area of 773 km^2 and it borders the Talamanca mountain range to the West, the Caribbean Sea to the East, the Madre de Dios River to the North, and the Toro River to the South. The climate in Matina is warm and humid, with abundant precipitation throughout the year (3,300 mm on average) and without well-defined seasons, although the heavier rains tend to occur between June and August, and between November and February. The temperature is more or less constant throughout the year with lows around 20-21°C and highs around 30-31°C. The primary economic activity in Matina is large-scale banana agriculture, which in 2012 occupied 9,873 ha of land and produced over 500,000 MT of banana, or nearly a quarter of the national banana production for export destined to North America, Europe and Russia (CORBANA, 2013). My research focused on the communities of Bataan, Matina, B-Line, Estrada, Zent, 28-Millas and 4-Millas, located within a 15 km radius of each other in the alluvial plain of the Matina River (see figure 1-5). These are

small communities, typically with less than a hundred households, except for Bataan and Matina, which concentrate larger populations and have more services such as high schools, clinics, or transportation.

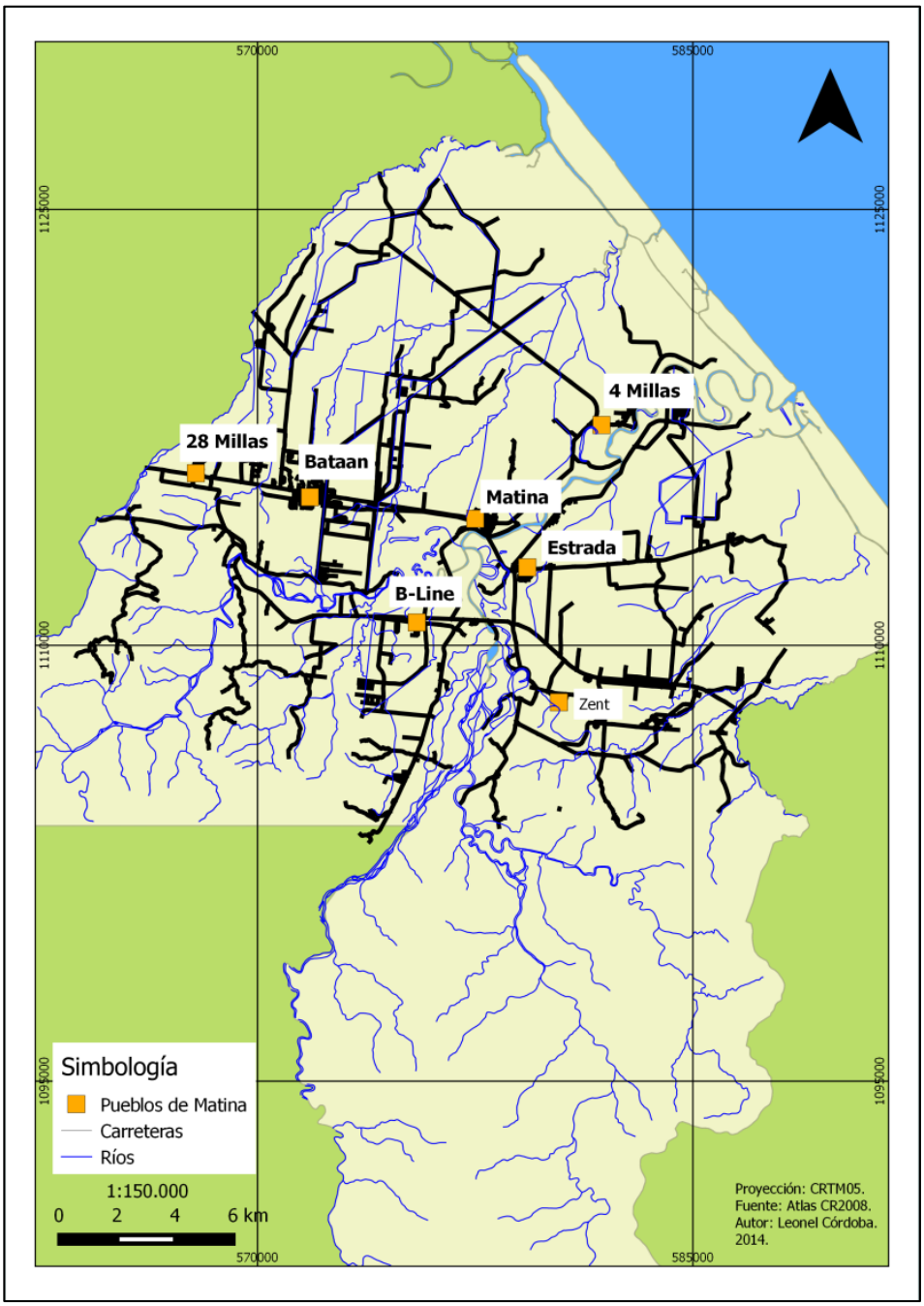

Figure 1-5. Location of research communities in Matina (Limón). Source: Leonel Cordoba (with permission).

Bribri Indigenous Territory: Waves of Colonization

Figure 1-6. Indigenous farmers bring plantains for sale to a sandbar on the Telire River in the community of Suretka (Talamanca, Limón). Source: Author.

The county of Talamanca (Limón) is on the South-Atlantic coast of Costa Rica and it encompasses the Bribri and Cabécar Indigenous Territories (although this dissertation focused only on Bribri communities). Since the 1500s, Talamanca has withstood three subsequent waves or attempts of colonization that have impacted the social and ecological organization of the Bribri in important ways (Rojas-Conejo, 2002). The first wave was the Spanish colonization, which was largely unsuccessful due to the resistance organized by Indigenous peoples. Nevertheless, the intermittent military attempts and the spread of European diseases decimated the original population. The second wave came in the early 1900s with the expansion of the UFCO in South-eastern Costa Rica. Initially, the UFCO did not practice any land conservation measures, relying instead on its ability to secure new lands once soil exhaustion rendered a plantation unprofitable (Marquardt, 2001). Hence, in 1909 the UFCO expanded its operations into the Sixaola River valley in Talamanca, displacing the Indigenous population

who was pushed to higher altitudes in the Talamanca mountains (Biesanz et al., 1999). However, unusually heavy floods in the 1920s and 1930s, compounded by a series of plant diseases affecting the crop, forced the UFCO to abandon the Sixaola valley in 1938 (Whelan, 2005). Still, by the time that the UFCO left, there had been lasting modifications to the ecosystem as a result of the clearing of forests and the excavation of drainage canals, as well as to the traditional Bribri lifestyle, particularly through the creation of a labour market that gave a definite push towards the region's integration into the cash economy (Whelan, 2005; Rojas-Conejo 2002). The third wave started towards the middle of the 20th century and it involved a deeper restructuring of the Indigenous ways of life, this time driven by the Costa Rican state (Rojas-Conejo, 2002). Although this third wave is very much a continuation of the processes that the UFCO set in motion, the changes go beyond the economic sphere to touch deeper aspects of Indigenous societies. For instance, the state imposed the Costa Rican educational curriculum, increased the presence of law enforcement institutions, and allowed for the establishment of non-Indigenous religious groups in the Bribri Indigenous Territory.

The county of Talamanca is situated between the counties of Perez Zeledón, Buenos Aires and Coto Brus to the west (on the Pacific slope of the Talamanca mountain range), the Atlantic Ocean to the east, Panama to the South, and the county of Limón to the north. The county of Talamanca overlaps roughly with the Sixaola River watershed, which is an international basin shared between Costa Rica and Panama. With 2,810 km^2, Talamanca is one of the larger counties in the country and it is extremely diverse as it extends from sea level to 3,500 masl in less than 40 km of horizontal distance. Hence, it is often divided into Lower Talamanca, which encompasses the areas below 500 masl including the coast, the Sixaola River valley and the start of the mountain range; and Upper Talamanca, which comprises the areas above 500 masl on the mountain range. The differences in climate and terrain between Lower

and Upper Talamanca translate into different forms of agriculture and land use. Upper Talamanca has very rugged terrain that is unsuitable for commercial agriculture but families maintain plots, called *huertos* ("orchards"), where they cultivate a variety of annual crops (tubers, roots, rice or maize), fruit trees (guava, pegibaye, oranges), perennial crops (cacao), medicinal plants (ginger), *musas* (plantain, bananas) and timber (laurel). Lower Talamanca contains a mix of traditional agriculture and more intensive forms of commercial plantain and banana agriculture. Among the variety of crops that are produced in Talamanca, only bananas, plantains and cacao beans have found stable markets and can be considered a source of income for families. Yet, the relative importance of these three crops varies over time due to economic and environmental factors, such as the fluctuations in demand and price of each of the crops, or the impact of natural disasters and plant disease. For instance, following the demise of large-scale banana agriculture in the Sixaola River valley, there was a period where residents returned to subsistence farming as their primary activity, supplemented by the sale of cacao beans. However, the appearance of the monilia fungus in 1978 caused the production of cacao to plummet by nearly 80 percent (Dahlquist et al., 2007). The devastating impact of monilia, together with the opening of the road between the Bribri Territory and Limón, provided the window of opportunity for the emergence of plantain as an alternative cash crop for Indigenous households. Currently Talamanca produces 52% of the plantain, 90% of the organic banana, and 6% of the commercial banana production in Costa Rica (Municipality of Talamanca, 2003).

The Bribri Indigenous Territory was created in 1977 as a result of the introduction of Costa Rican Indigenous Law and it is governed by a local Indigenous government known as the *Asociación del Desarrollo Integral Indígena Bribri de Talamanca*, ADITIBRI, (Integrated Indigenous Bribri Development Association of Talamanca). The three communities that are

part of this research are Shiroles, Suretka and Amubrë in the Bribri Indigenous Territory in Lower Talamanca (see figure 1-7). The Bribri Territory spans 437 km^2 and has a population of 8,500 residents who live predominantly in the communities of Suretka and Shiroles. Suretka and Shiroles are contiguous to each other and they are situated on the road linking the territory with the coast, whereas Amubrë is on the other side of the Telire River (a major tributary of the Sixaola River), which requires a boat to cross. The fact that there is no direct road access from the lowlands to Amubrë is significant because the community is less exposed to non-Indigenous influences. Consequently, residents in Amubrë tend to maintain a more traditional lifestyle that is reflected in their agriculture practices, compared to those in the communities of Suretka and Shiroles where conventional agriculture has had a higher degree of penetration. A sandbar on the Telire River in Suretka serves as a sales point for plantains and bananas as middlemen (and they are all men) arrive with their trucks to purchase fruit from the farmers who bring their produce via water or land. The middlemen then sell the fruit in the central depot in the capital city of San Jose that supplies smaller national retailers. As well, there are several farmer cooperatives that operate in the Bribri Indigenous Territory and who sell the fruit to the international market or process it (e.g. as plantain chips).

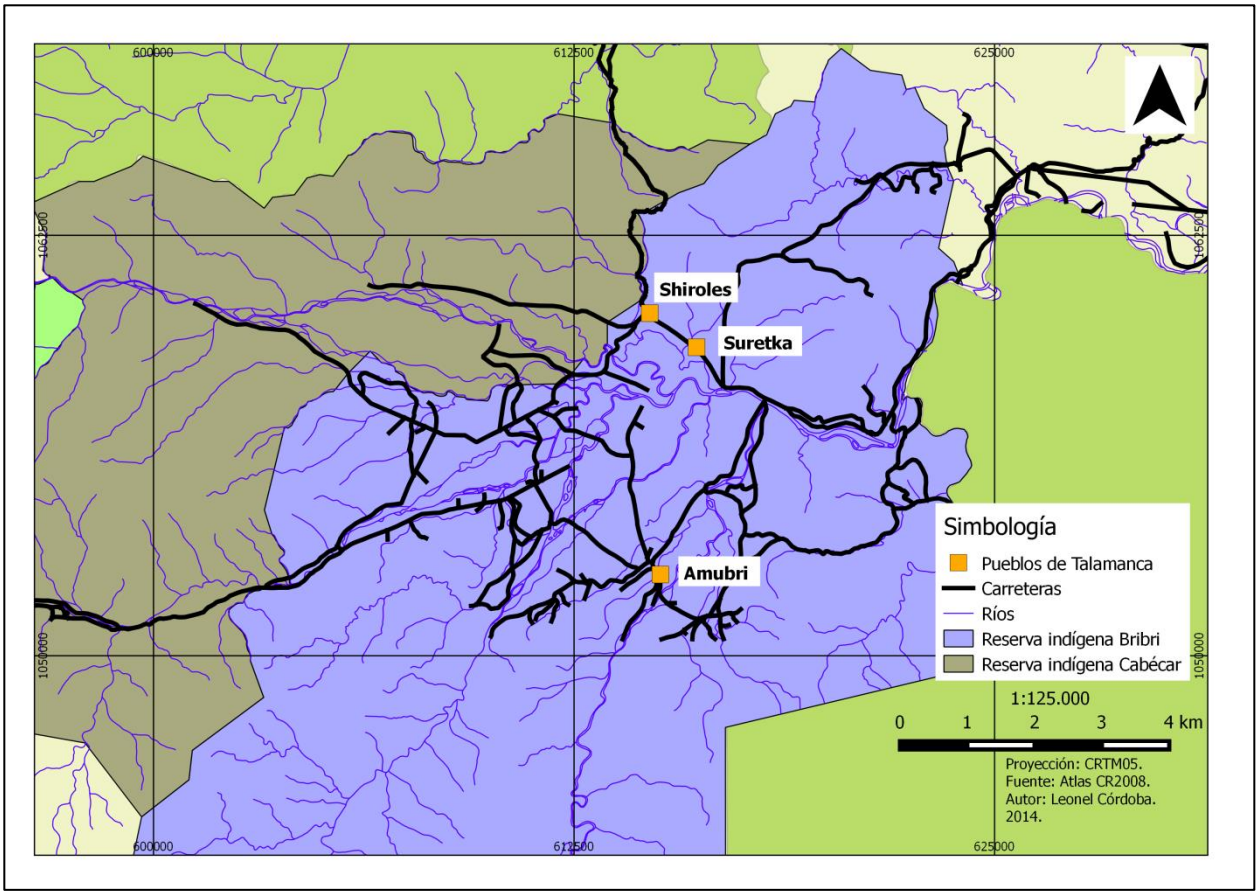

Figure 1-7. Location research communities in the Bribri Indigenous Territory. Source: Leonel Cordoba (with permission).

Volcán de Buenos Aires: Trade Liberalization and the Pineapple Expansion

Traditionally, Costa Rica's agricultural exports have been coffee and bananas. However, in the 1980s the Costa Rican government underwent a period of trade liberalization, which propelled the establishment of pineapple agriculture as the government granted significant economic incentives to firms willing to develop non-traditional crops for export. The expansion of pineapple monoculture in Costa Rica was swift; in 1995 there were approximately 5,500 ha of land dedicated to pineapple agriculture in the country, by 2006 this figure had increased almost six-fold to 30,000 ha (MAG, 2007). The production of pineapples in Costa Rica began in the county of Buenos Aires (Puntarenas) in the South-Pacific region, led by the

Pineapple Development Company (PINDECO), which is a subsidiary of Fresh Del Monte Produce. The quick expansion of pineapple agriculture was partially due to the enormous success of the MD-2 cultivar that PINDECO developed specifically for the climate and terrain of the Buenos Aires area, which includes steady temperatures between 23-30˚C, abundant sunlight, acidic soils, and flat terrains in the alluvial plains of the Térraba River (MAG, 1991). Because the MD-2 pineapple is perfectly adapted to the biophysical conditions of Buenos Aires, the fruit is hardy and produces high yields (Aravena, 2005; Bonatti et al., 2005). In addition, this particular variety has a long shelf life, it tastes sweeter than other cultivars, and it has strong aesthetic appeal, making it suitable for the North American market. Combined with the very generous tax subsidies that the Costa Rican government granted to enterprises of non-traditional exports, Costa Rica quickly overtook Côte d'Ivoire as the world's leading exporter of fresh pineapples (Vagneron et al., 2009). In 2010, Costa Rica exported 1.7 million tons of pineapples, making them the second most important agricultural commodity for the country after bananas (SEPSA, 2014).

Figure1-8. Pineapple plantations near the community of Volcán de Buenos Aires (Puntarenas). Source: Author.

Today, pineapples are grown in two regions in Costa Rica: Buenos Aires and the Northern portions of the provinces of Alajuela, Heredia, and Limón. This dissertation focuses only on the pineapple production from the county of Buenos Aires, which has 4,500 ha of land dedicated to pineapple monoculture, although unofficial estimates suggest that this figure could be closer to 14,000 ha (Aravena, 2005). The two communities that are part of this research are Volcán and Altamira, situated on the west side of the Buenos Aires county within the Volcán River watershed (see figure 1-9). The Volcán River watershed has a population of 3,500 people, divided into 12 communities. This watershed was one of the first places where PINDECO established large-scale operations in 1978. Prior to that, the watershed was settled in the 1900s by non-Indigenous families of Panamanian descent, whose livelihoods depended primarily on cattle ranching while they also cultivated sugarcane, coffee and vegetables for household consumption. The company bought the lands in the alluvial plain of the Volcán River between 400 and 700 masl, that were flat enough to permit the operation of the large

machinery that is necessary to harvest pineapples (see figure 1-8) The upper reaches of the watershed, where the land is too rugged, continue to be used for pasture, sugar cane, or coffee.

The Volcán River watershed is approximately 230 km^2 in size and it contains five Holdridge life zones: montane rainforest, lower montane rainforest, premontane wet forest, tropical wet forest, and tropical moist forest (McConnell, 2008). The Volcán River is a tributary of the Térraba River, a watershed of national importance as well as of international significance as it feeds the Térraba-Sierpe wetland, which is recognized by the Ramsar Convention. Finally, the headwaters of the Volcán River are within the buffer zone of La Amistad International Park, a biodiversity hotspot in Central America (McConnell, 2008). The watershed averages 3,000 mm in annual precipitation that falls mostly during the rainy season (between May and November). It has steep gradients and soils that are acidic, compacted, of clayey texture and very low fertility (Calvo-Alvarado et al. 2007).

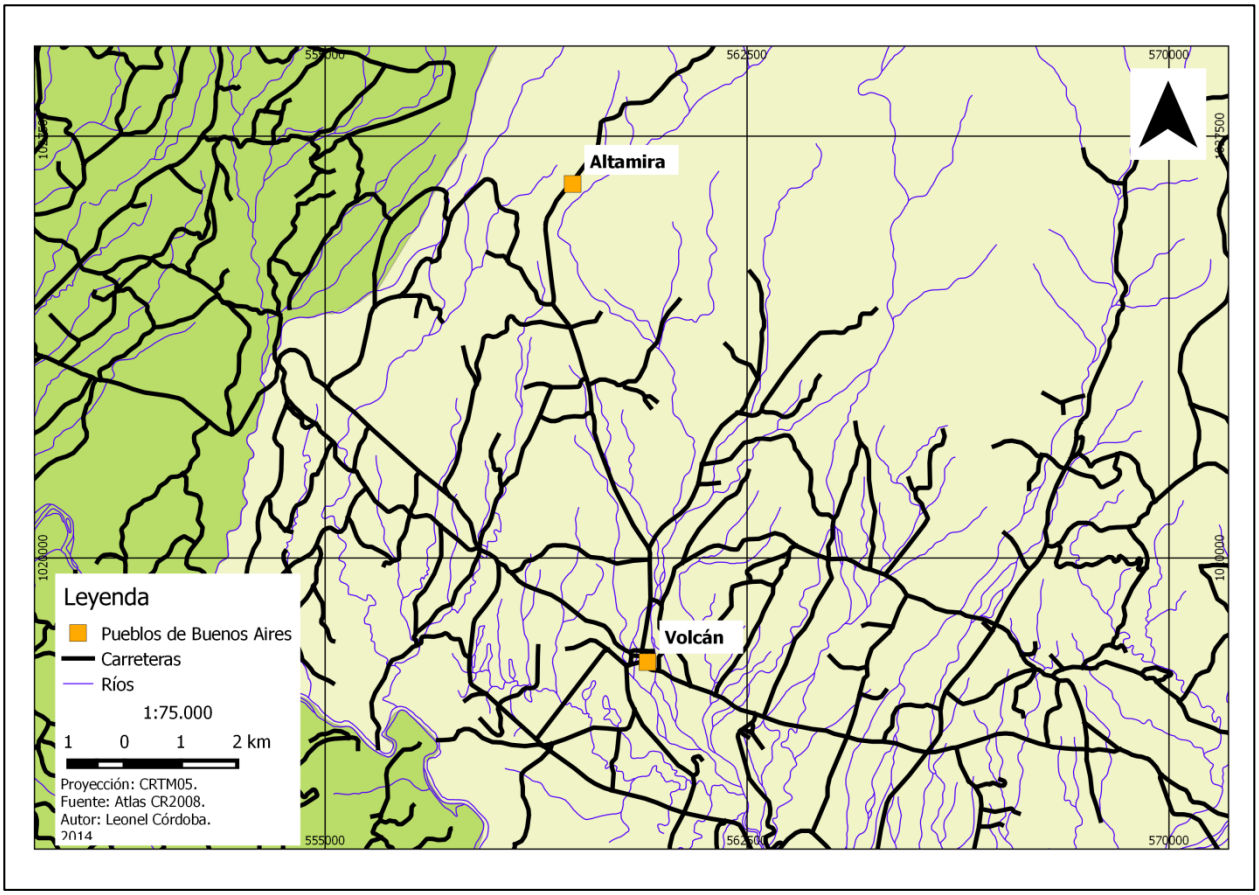

Figure 1-9. Map of Buenos Aires county with the communities of Volcán and Altamira. Source: Leonel Cordoba (with permission)

Theoretical Framework and Definitions

There are different entry points for exploring the interplay between ecosystems and human well-being. In my case, I approached this nexus from two complementary concerns: improving human well-being in resource-dependent communities in the tropics and doing so while maintaining the resilience of critical ecosystem services. Hence, the literatures on resilience thinking and international development are two of the platforms that provide theoretical grounding for this dissertation.

Resilience Thinking

Rooted in complexity science and systems thinking, resilience thinking offers a framework to understand processes of change and persistence. Resilience appeared in the literature of systems ecology during the early 1970s as a way of understanding non-linear ecosystem dynamics. These insights were applied primarily to issues related to resource management, such as insect outbreaks in the boreal forest, eutrophication of lake ecosystems, restoration of wetlands, management of grazed rangelands or the protection of coral reefs (cf. case studies in Gunderson and Pritchard (2002). In the 1990s resilience thinking began to widen its scope to the study of more broadly defined human-environment interactions. As resilience scholars began to explore how the concept of resilience could be applicable in the understanding of societies, particularly those dependent on natural resources (Adger, 2000), the scope and focus of resilience research shifted from being centered on ecology and conservation to encompassing a wider array of topics organized around human needs including natural disaster management (Pelling, 2003; Adger et al., 2005; Gunderson, 2010), vulnerability (Chapin III et al., 2004; Adger, 2006; Miller et al., 2010), poverty traps (Allison and Hobbs, 2004; Enfors and Gordon, 2008) and governance (Folke et al., 2005; Olsson et al., 2006; Huitema et al., 2009, Armitage, 2007).

The definition of resilience has morphed and changed over time reflecting the broadening of the application of resilience to matters of ecology to matters of a more social nature (see table 1-3). While resilience continues to be an evolving concept, there is consensus around the following definitions: Engineering resilience is defined as a system's speed of return to equilibrium following a shock (Holling, 1996), which denotes a narrow conception of ecosystems as having a single steady state equilibrium. Engineering resilience is usually contrasted with ecological resilience, which is defined as the magnitude of disturbance that a

system can absorb before it shifts to an alternative steady state (Holling, 1996). Ecological resilience was introduced in opposition to the previous idea of a single steady-state equilibrium, and it emerged from observations of system's behaviour, in particular, the ability of a system to withstand shock and maintain critical relationships, the existence of multiple stable states, and the episodic nature of changes in a system (Holling, 1973). Social-ecological resilience has been defined as an emergent property of a system that depends on: (1) the amount of disturbance that a system can absorb and still remain within a domain of attraction; (2) the capacity of a system to learn and adapt; and (3) the degree to which the system is capable of self-organizing (Carpenter et al., 2001; Folke, 2006). Hence, social-ecological resilience follows similar lines to ecological resilience but it incorporates ideas about adaptation, learning and self-organization. The term social resilience (Adger, 2000) was coined as the theoretical insights from resilience thinking began to be applied more widely to social systems. Clearly, the adoption of ecological heuristics to a social context cannot be assumed to be unproblematic (Davidson, 2010), however, the intention in talking about social resilience was primarily to use resilience concepts as analogies to guide the understanding and exploration of social and institutional processes (see for example Abel et al., 2006 or Berkes & Ross, 2013). More recently, resilience has been understood as transformability, or as the capacity of a social-ecological system to navigate a transition from its present state to an alternative state following a desired pathway (Folke et al., 2010). Hence, the latest formulation of resilience builds on the notions of ecological resilience and adaptation from the previous conceptualizations, but it highlights the interplay of persistence, adaptation, and transformation as necessary to preserve particularly desirable characteristics of a system. Finally, it is important to note that resilience itself is not a normative concept, that is, resilience is neither a desirable nor an undesirable property of social-ecological systems. Systems can be

resilient in an undesirable state creating rigidity traps and vice versa, systems can lack resilience in very desirable configurations.

Table 1-3.
The Evolution of the Concept of Resilience

	Definition	**Emphasis**	**Key references**
Engineering resilience	System's speed of return to equilibrium following a shock	Return time to recover, efficiency, equilibrium	Pimm (1984)
Ecological resilience	Ability of a system to withstand shock and maintain critical relationships	Buffer capacity, withstand shock, persistence, robustness	Holling (1996)
Social-ecological resilience	1) Amount of disturbance that a system can absorb and still remain within a domain of attraction; (2) capacity for learning and adaptation (3) the degree to which the system is capable of self-organizing	Adaptive capacity, learning, innovation	Carpenter (2001); Folke (2006)
Social resilience	Resilience as metaphor for social systems	Social dimensions, heuristic device	Adger (2000)
Resilience as transformation	Persistence, adaptation, transformation	Transformation, pathways	Folke et al. (2010)

Although there is a wide range of topics that can be examined from a resilience perspective, at its core, there are three concepts that provide a common framework for resilience thinking: First, resilience deals with complex adaptive systems (CAS) in the sense that these systems have components that interact to respond to changing external conditions and thus these systems are able to adjust their behaviour accordingly (Norberg & Cumming, 2008; Chapin et al., 2009). For instance, there is an important feedback in resource-dependent communities between the application of agrochemicals and the price of the crop. Farmers often apply more agrochemicals when the price goes up to take advantage of a good year and *vice versa.* Second, CAS include social elements (such as labour, markets, or family relations) as well as ecological elements (such as soil nutrients, precipitation, or dengue) and there are important feedbacks between the social and ecological components that might result in positive or negative feedback loops. These systems are referred to as coupled social-ecological systems (SES), or coupled human-environment systems (Berkes & Folke, 1998; Berkes et al., 2003). The

term social-ecological system is meant to emphasize that these are distinct from social or ecological systems alone (Westley et al., 2002). In this dissertation I consider the resource-dependent communities and their surrounding environment as a social-ecological system. Third, scale is important because complex adaptive social-ecological systems are embedded in nested hierarchies (Gunderson & Holling, 2002) and certain characteristics of the system only manifest at particular spatial or temporal scales. As well, key phenomena affecting the stability of the system may arise as the result of cross-scale interactions (Norberg & Cumming, 2008). For instance, exposure to dengue in communities in Costa Rica is a product of the interactions between phenomena at different temporal scales, such as the formation of puddles near people's houses after storms, which lasts only a few hours; the life cycle of the *Aedes aegypti* mosquito, which lasts 8 to 10 days; and the change in climate that produces increasing (or decreasing) precipitation, which occurs over several years or decades.

In the past four decades, resilience thinking has become a widely influential concept shaping the way in which we approach environmental governance and management. In general, governance comprises the structures and processes by which societies share power in a broad sense, involving a wide range of formal and informal institutions, processes and actors (Lebel et al., 2006). Environmental management is more specific and it refers to the operationalization of the principles and the vision contained in environmental governance (Folke et al., 2005). That is, the set of principles that are used to organize and regulate the interactions of humans with their natural environment is environmental governance; in its applied form it becomes environmental management. In this document, environmental management will be used as a generic term to designate all forms of management activities – modern and traditional, anthropocentric and eco-centric, commercial and subsistence – that are used to regulate the relationship between humans and nature. Resilience thinking has been

instrumental in shaping adaptive environmental management (AEM) (Holling, 1978; Walters, 1986; Lee, 1994) and adaptive co-management (Pinkerton, 1994; Armitage et al., 2007; Plummer, 2009), as well as adaptive governance (Olsson et al., 2006; Armitage & Plummer, 2010). Adaptive environmental management is an approach to managing ecosystems under conditions of uncertainty, where management policies have two objectives: First, to gain knowledge of the dynamics of the system and second, to understand how human intervention will affect it (Gunderson et al., 2008). Thus, AEM is an iterative process of learning by doing where policies are seen as hypotheses and management interventions as experiments.

In terms of governance, it is becoming increasingly clear that conventional forms of environmental governance are poorly suited to deal with the current conditions of rapid and far-reaching ecosystem change, where uncertainty is high, controllability is low and multiple stakeholders hold conflicting views (Gallopin et al., 2001). Adaptive governance offers guiding principles to deal with the complex and uncertain nature of social-ecological systems. These principles revolve around: 1) Gaining knowledge and understanding of ecosystem dynamics, particularly through the combination of different forms of knowledge systems (Folke et al., 2005); 2) Practicing adaptive environmental management, through iterative testing, monitoring, and re-evaluation that enhance adaptive response to sudden change (Dietz et al., 2003; Folke et al., 2005); 3) Building redundant, flexible, polycentric and multilayer institutions to improve adaptive capacity and cross-scale interactions (Dietz et al., 2003; Folke et al., 2005; Lebel et al., 2006); 4) Fostering wider participation and analytical deliberation that might lead to self-organization (Dietz et al., 2003; Lebel et al., 2006). These guiding principles offer a lens to examine the forms of environmental governance and management that regulate the flow of ecosystem services and benefits from agricultural social-ecological systems.

While resilience thinking continues to be central in the exploration of the interface between environmental and social concerns, critiques have arisen regarding the lack of a clear engagement with issues of power. Since resilience considers social-ecological systems as its unit of analysis, it follows that power dynamics are embedded in and inseparable from the dynamics of the social-ecological system. Accounting for these relationships is particularly important as the scope and focus of resilience research has shifted from being centred on ecology and conservation to encompass a wider variety of topics organized around human needs. Efforts to add precision to the notion of resilience have tackled the question "resilience of what to what?" (Carpenter et al., 2001), while the question "resilience for whom?" has been by far less explored (e.g. Cote and Nightingale, 2011; Brown, 2014). Incorporating these indirect forces into a resilience analysis is challenging because their diffuse and complex nature makes them difficult to measure, and the relative importance of social forces such as poverty or inequality is politically charged and highly contested. Yet, the purported political neutrality in resilience is perceived as a lack of engagement with normative concerns or as outright endorsement of the status quo that insufficiently challenges the power relationships underlying inequities resulting from environmental management and governance processes. There have been few attempts in the literature to respond to these criticisms and to consider constructive ways of integrating resilience and power frameworks (cf. Peterson, 2000; Armitage, 2008).

Ecosystem Services

Humans have recognized their dependence on nature since time immemorial but the concept of ecosystem services, as we know it today, emerges within the research literature in the 1970s (cf. Westman, 1977; de Groot, 1987). Originally, economists and conservation biologists proposed the idea of ecosystem services largely as a metaphor to help to raise

awareness and to garner support for conservation by highlighting the value of nature to humans, that is, the services that nature provides for our survival (Norgaard, 2010; Gomez-Baggethun et al., 2010). At the same time, the concept of ecosystem services served as a pedagogical tool that emphasized the connections between human well-being and nature (Peterson et al., 2009). In the 1990s there were a number of keystone publications that helped to mainstream the concept (cf. Costanza & Daly, 1992; Daily, 1997; Costanza et al., 1997; de Groot et al., 2002) and with the MEA (2003, 2005), ecosystem services became firmly established in the policy agenda. Indeed, the number of journal publications on ecosystem services has risen exponentially in the past two decades (Fisher et al., 2009), and today there are a variety of dedicated journals and conferences that attract interdisciplinary scholars, businesses and policy-makers.

Within the diverse and growing literature on ecosystem services, there are three ongoing and interrelated debates that lay the ground for this dissertation: First, the intuitive appeal of the concept of ecosystem services that is responsible for its broad adoption, is also a source of confusion. The framework proposed by the MEA (2003) grouped ecosystem services into the aforementioned categories –provisioning, regulating, cultural, and supporting services—and related these to different dimensions of human well-being that included material wealth, health, safety and security, good social relations, and freedom of choice (figure 1-2). While this conceptualization of the link between ecosystems and human well-being has served the goals of the MEA, key aspects of the relation remain untested and they pose a challenge for evaluating, framing, and classifying ecosystem services, as well as for teasing out the impact of ecosystems on human well-being. Thus, there have been many and diverse calls pointing to the need to add precision to the MEA framework (cf. Kremen, 2005; Hein et al., 2006; Boyd &

Banzhaf, 2007; Wallace, 2007; Fisher & Turner, 2008; Fisher et al., 2009; Maynard et al., 2010; Raudsepp-Hearne et al., 2010; Daw et al, 2011; Chan et al., 2012).

One way in which scholars have tried to add precision to the concept of ecosystem services proposed by the MEA is by examining how closely the production of an ecosystem services is linked to an improvement in human well-being. This has led to different versions of the ecosystem service 'cascade' (see figure 1-10) where the link between ecosystems and well-being is disaggregated to various degrees (see de Groot et al., 2010; Potschin & Haines-Young, 2011). Among these, some contend that ecosystem benefits depend on services but are linked directly to a change on human welfare, hence, photosynthesis is a service, fresh produce is a benefit (Boyd & Banzhaf, 2007; Fisher & Turner, 2008; Kumar, 2010). Along the same lines, others have proposed to classify ecosystem services in terms of means and ends to avoid double-counting (Wallace, 2007), or intermediary and final services (Fisher & Turner, 2008; Fisher et al. 2009).

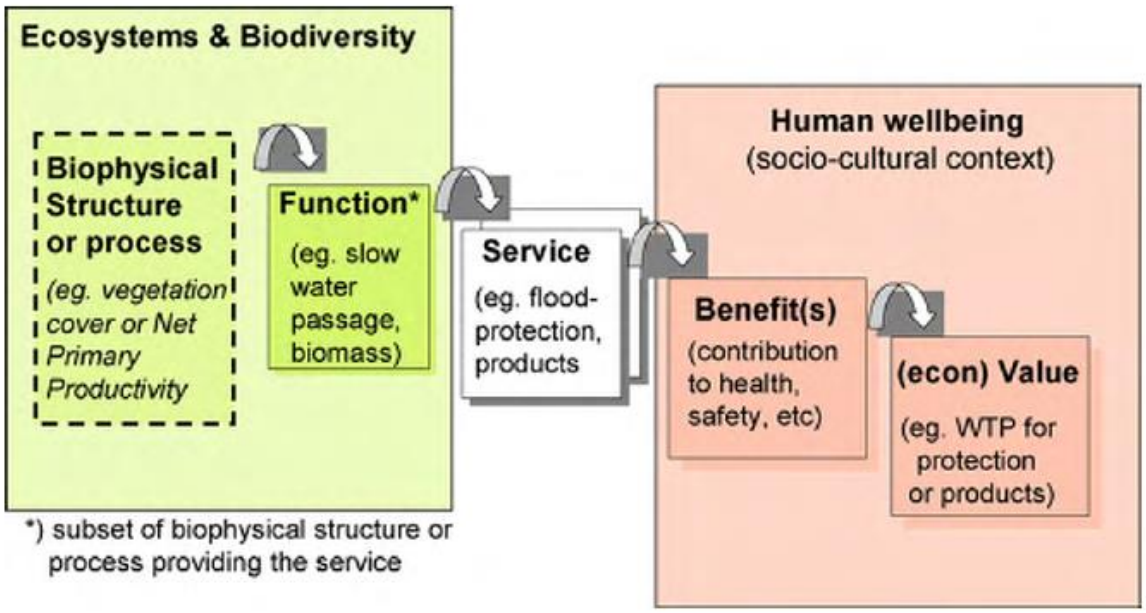

Figure 1-10.. Ecosystem service cascade. Source: De Groot Et Al. (2010), Potschin & Haines-Young (2011)

While there are a variety of classifications that unpack this link, they can be grouped under two schools of thought (Nahlik et al., 2012): those who consider that ecosystem services are the benefits that humans derive from ecosystems (Costanza et al., 1997; MEA, 2005; Harrington et al., 2010), and those who subscribe to the idea that ecosystem services are the elements of the ecosystem that support human benefits but are not benefits by themselves (Daily, 1997; de Groot et al., 2002; Kremen, 2005; Boyd & Banzhaf, 2007; Fisher et al., 2009; Nelson et al., 2009). Both conceptualizations have merits and the degree to which they are useful depends on the scope and the purpose of the assessment. For instance, in large-scale assessments, such as the MEA (2005) or Costanza et al. (1997), it makes sense to assume that ecosystem services are benefits. On the other hand, for small-scale assessments or in situations where ecosystem services might accrue to different stakeholders, conceptualizations that provide finer resolution are better suited.

The second ongoing conversation within the literature of ecosystem services that is relevant to this dissertation is the bourgeoning body of work on ecosystem services and poverty alleviation. It is not surprising that the concept of ecosystem services is increasingly seen as an entry point to issues of poverty and vulnerability (Howe et al., 2013; Reyers et al., submitted) since, at its core, ecosystem services are an exploration of the relationship between nature and human well-being that shares similarities with the environment-poverty nexus that has long been explored in development studies. In 1987, the development community took the cue from the World Commission on Environment and Development (the Brundtland Commission), which promoted the view that poverty and environmental degradation were mutually reinforcing phenomena. They contended that the poor contribute to environmental degradation because they are forced to operate in short time-frames to satisfy their immediate needs within a limited range of options. In turn, the degradation of natural resources translates

into a variety of negative impacts on human well-being (WCED, 1987). While at times environmental degradation and poverty interact in reinforcing ways, as a general rule, the idea of the vicious cycle does not stand to empirical scrutiny (Forsyth et al. 1998; Scherr, 2000; Ravnborg, 2002, 2003; Dasgupta et al., 2005). However, it is also true that poverty and environmental degradation share common drivers, e.g. environmental contamination negatively impacts both ecosystems and human health.

The relationship between poverty and the environment resists easy characterization because it is complex and context-specific. The ecosystem services literature offers an opportunity to unpack the nature-poverty nexus by providing a framework to guide the exploration on the ways in which humans benefit from nature. While lack of knowledge is not the only barrier to poverty alleviation, a better understanding of how ecosystems function can be applied to matters that would improve well-being such as increasing food yields and water quality or reducing vulnerability to natural hazards (De Clerk et al., 2006). Recent important contributions that examine the relationship between ecosystem services and poverty include: The synthesis by Reyers et al (submitted) that offers a typology combining the classification of the MEA with a consideration of how resource-dependent communities benefit from these services, whether they derive a direct benefit, e.g. subsistence fishers, or an income-mediated benefit, e.g. fishers who sell their catch in the market (see figure 1-11). As well, the work by Daw et al. (2011) suggesting to disaggregate human well-being to better understand the impact of changes in provisioning services on the well-being of different stakeholder groups at the local level. Finally, the ongoing work by Hamann (unpublished) to quantify and correlate bundles of ecosystem services with bundles of human well-being in South Africa.

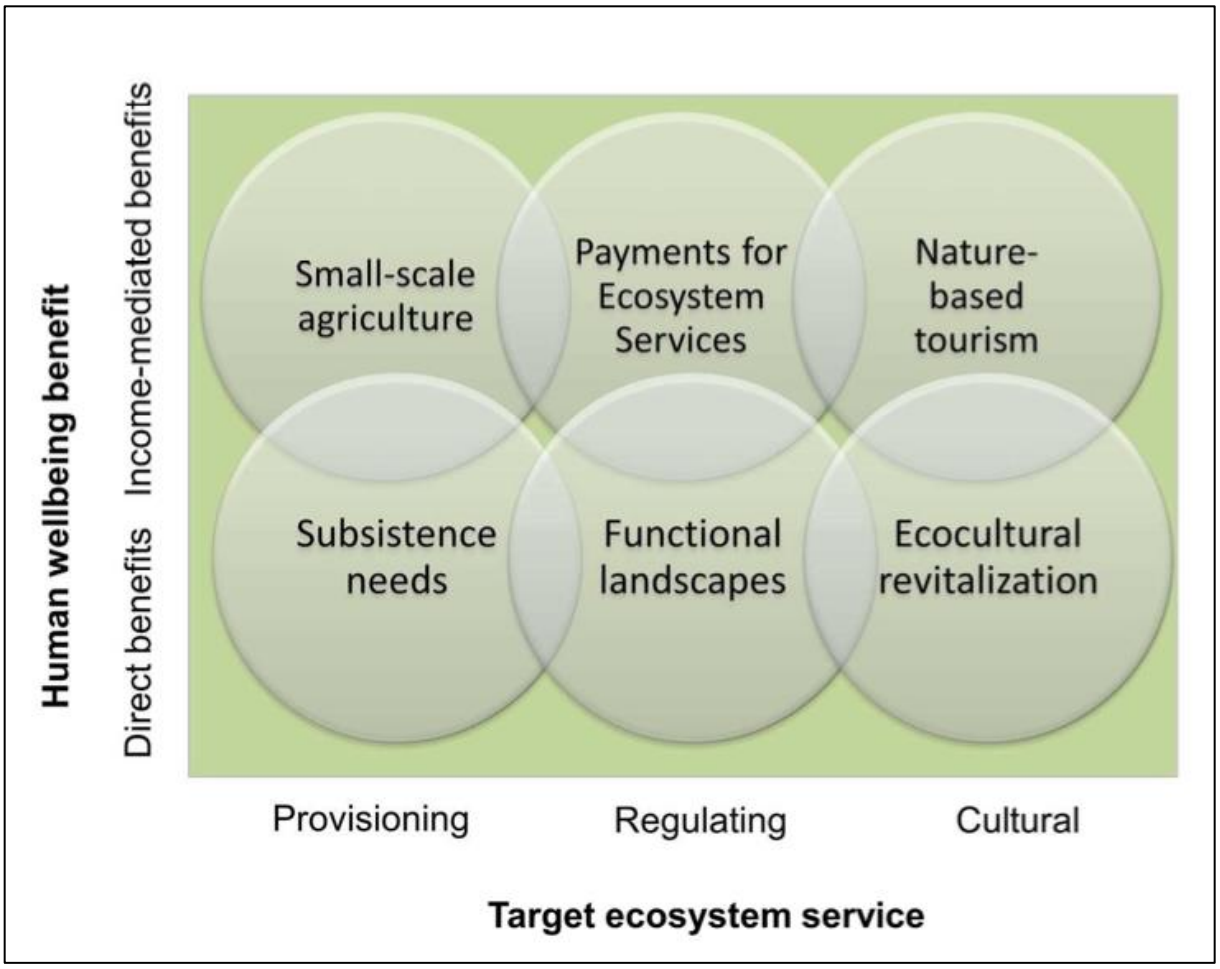

Figure 1-11. Typology of ecosystem services distinguishing between direct services and those that are income-mediated. Source: Reyers et al. (submitted)

The last foci in the ecosystem service literature that provides a footing for this dissertation is the idea of trade-offs in ecosystem services. Ecosystem services appear in nature as bundles of variables that interact across space and time (Rodriguez et al., 2006; Raudsepp-Hearne et al., 2010). For instance, a forest does not produce exclusively timber, it produces timber, habitat for squirrels, it recycles carbon, it photosynthesizes sunlight, it prevents erosion, and more. Although the idea of bundles of ecosystem services is now widely recognized, much remains unknown about the interactions between different services and the impact of common drivers on ecosystem services bundles (Bennett et al., 2009). Sometimes a driver might create a trade-off, e.g. land intensification increases crop yields but reduces

aesthetic appeal. Other times, a driver might result in a synergy between two ecosystem services, e.g. wetland restoration increases flood control and it also increases water quality. The fact that according to the MEA provisioning services are on the rise yet the rest of ecosystem services are decreasing, implies a trade-off at some level, that is, some types of ecosystem services are being optimized at the expense of other types of ecosystem services (Raudsepp-Hearne et al., 2010). The evidence suggests that, in general, provisioning ecosystem services are prioritized over regulating, cultural and supporting services in that order (Foley et al., 2005). There are profound implications that follow from this particular sequencing of priorities in ecosystem service management. The focus on trade-offs is important for three reasons: First, trade-offs might result on unwanted declines of ecosystem services, particularly when environmental management is geared towards optimizing one service at a time. Second, trade-offs might lead to regime shifts to undesirable states (Bennett et al., 2009). Third, since social-ecological systems are strongly coupled, it follows that these trade-offs have ecological and social dimensions. Therefore, the consequences of trade-offs have different impacts on the well-being of different socioeconomic groups (Daw et al., 2011).

Conceptualizations of human well-being

The notion and measurement of human well-being has evolved from a very utilitarian understanding of well-being based on standardized measures of material welfare, towards more integrative, contextual, and multi-dimensional approaches. In the 1940s, following the Great Depression, the economic recovery after World War II and the appearance of Keynesian economics, a nation's gross domestic product (GDP) became the measure of a nation's well-being (England, 1998). GDP is simply the total market value of all final goods and services produced in a country in a given year, which includes the total consumer, investment and government spending, plus the value of exports, minus the value of imports. The simplicity that

comes from a numerical indicator made GDP easy to standardize and it soon became a convenient shorthand to compare welfare across countries and through time. However, GDP is no more and no less than an indication of economic activity and as such, it leaves out any social dimension that might contribute to human well-being in a non-monetary way, such as an individual's support network or their sense of identity. As well, GDP does not indicate how wealth is distributed within a nation because it is reported as a per capita average. Finally, GDP fails to draw a link to the natural environment that supports economic activity, indeed, things such as natural disasters or environmental degradation might appear as temporary increases in GDP.

Ongoing criticisms of GDP pushed the notion of well-being towards more multidimensional conceptualizations that considered material welfare as a necessary, but insufficient, condition for people to flourish. In particular, noting that aggregate growth at the nation level did not translate into better living conditions for the poor, the International Labour Organization introduced the basic needs approach in the 1970s. The basic needs approach proposes to build a composite of several indicators that represent essential human needs such as nutrition, education, health, sanitation, water supply and housing (Streeten & Burki, 1978; Hicks & Streeten, 1979). However, some contest that, while the basic needs approach is certainly more people-centred than GDP, its fundamental premise is underlined by the same neoliberal frame of mind. That is, the basic needs approach is still concerned primarily with the supply of commodities, albeit a range of them, and it neglects questions related to human agency and freedom (Nussbaum & Sen, 1993).

In 1990, the United Nations adopted Amartya Sen's capabilities approach to frame their Human Development Report. According to Sen (1988, 1999), people's well-being depends on

'functionings', which are the various things that a person may value doing or being, such as attending a live concert or being healthy. Capability refers to a person's freedom to achieve and enjoy those functionings. From Sen's point of view, improving human well-being depends on removing the obstacles that stand on the way of expanding people's freedom to achieve the functionings that they value (Deneulin & Shahani, 2009). Taking even a relatively frivolous functioning such as the concert example above, one can see how there are a lot of factors that might interfere with a person's capability to fulfill it. For instance, having enough disposable income to purchase the ticket is a factor, but things such as having appropriate clothes to wear, feeling confident that they will not be denied entry to the concert hall based on their gender or ethnicity, or feeling safe coming home at night, are also factors that might interfere with a person's capability to fulfill this functioning. Hence, in this case, improving well-being could mean anything from creating opportunities to earn income to enacting policies to eradicate violence and bigotry.

One of the difficulties with Sen's capabilities approach is dealing with the fact that there are as many functionings, and as many combinations of functionings, as there are people, making it difficult to communicate and to compare well-being. Although with some initial reluctance, Sen collaborated in creating the Human Development Index (HDI) based on the capabilities approach for the Human Development Report (Fukuda-Parr, 2003). The HDI is a composite index that includes indicators of income, literacy, and life expectancy into a single measurement. The idea behind the HDI is that the three indicators represent functionings that are universally shared by all people, that is, people enjoy having a decent standard of living, being knowledgeable, and having long lives (Fukuda-Parr, 2003). Hence, the HDI allows for easy comparison while maintaining some of the complexity of the capabilities approach. In

another attempt to synthesize the diversity of functionings and human experience, Nussbaum (2000) developed the list of ten central human functionings that are shown in table 1-4.

Table 1-4.
Nussbaum (2000) List of Central Human Functionings

Life	Being able to live to the end of a human life of normal length; not dying prematurely, or before one's life is so reduced as to be not worth living.
Bodily health	Being able to have good health, including reproductive health; to be adequately nourished; to have adequate shelter.
Bodily integrity	Being able to move freely from place to place; having one's bodily boundaries treated as sovereign, i.e. being able to be secure against assault, including sexual assault, child sexual abuse, and domestic violence; having opportunities for sexual satisfaction and for choice in matters of reproduction.
Sense, imagination, thought	Being able to use the senses, to imagine, think and reason—and to do these things in a "truly human" way, a way informed and cultivated by an adequate education. Being able to use imagination and thought in connection with experiencing and producing self-expressive works and events of one's own choice, religious, literary, musical, and so forth. Being able to use one's mind in ways protected by guarantees of freedom of expression with respect to both political and artistic speech, and freedom of religious exercise. Being able to search for the ultimate meaning of life in one's own way. Being able to have pleasurable experiences, and to avoid non-necessary pain.
Emotions	Being able to have attachments to things and persons outside ourselves; to love those who love and care for us, to grieve at their absence; in general, to love, to grieve, to experience longing, gratitude, and justified anger. Not having one's emotional development blighted by overwhelming fear and anxiety, or by traumatic events of abuse or neglect.
Practical reason	Being able to form a conception of the good and to engage in critical reflection about the planning of one's own life.
Affiliation	Being able to live for and towards others, to recognize and show concern for other human beings, to engage in various forms of social interaction; to be able to imagine the situation of another and to have compassion for that situation; to have the capability for both justice and friendship. Having the social bases of self-respect and nonhumiliation; being able to be treated as a dignified being whose worth is equal to that of others. This entails, at a minimum, protections against discrimination on the basis of race, sex, religion, caste, ethnicity, or national origin.
Other species	Being able to live with concern for and in relation to animals, plants, and the world of nature.
Play	Being able to laugh, to play, to enjoy recreational activities
Control over one's environment	Political: Being able to participate effectively in political choices that govern one's life; having the right of political participation, protection of free speech and association. Material: Being able to hold property, not just formally but in terms of real opportunity; an having property rights on an equal basis with others; having the right to seek employment on an equal basis with others' having the freedom from unwarranted search and seizure. In work, being able to work as a human being, exercising practical reason and entering into mutual relationships of mutual recognition with other workers.

Because human well-being is increasingly characterized as multidimensional, there has been a tendency to define lists of essential components for having a good quality of life (Alkire,

2002). Among these lists, an extensive survey of the literature conducted by Cummins (1996) concluded that the following seven dimensions are important for having quality of life: material well-being, health, productivity (in the sense of enjoying meaningful work), intimacy and friendship, safety, community, and emotional well-being (Cummins, 1996). As well, the very influential work of Narayan et al. (2000), which involved a participatory, cross-cultural study exploring subjective understanding of poverty by the poor themselves identified a somewhat overlapping list. Other multidimensional conceptualizations of well-being include the work of Max-Neef on Human Scale Development (Max-Neef et al., 1992). Max-Neef uses a matrix to show the interactions between what he considers axiological and existential needs. The axiological needs include subsistence, protection, affection, understanding, participation, leisure, creation, identity and freedom. The existential needs are identified as being (in the sense of having certain attributes), having (in the sense of institutions, norms, laws), doing (in the sense of actions) and interacting (in the sense of spaces). Max-Neef's conceptualization of human well-being is systemic in that he argues that all of these needs are interrelated and interact with one another, as well, they are non-hierarchical.

Stemming from a growing discontent with, and questioning of, Western development discourse upon which many of the above ideas of human well-being are predicated, the concept of *buen vivir* (roughly translated as living well or good living) appeared in Latin America towards the turn of the 21st century (Viteri-Gualinga, 2002; Gudynas, 2011; Gudynas & Acosta, 2011; Villalba, 2013). The *buen vivir* is a pluralistic concept that captures a variety of conceptualizations of well-being, many with roots on South American Indigenous thought. Hence, in Bolivia is popular the Aymara concept of *suma qamañi* and its Ecuadorian equivalent is *sumak kawsay*, the Kichwa word for fullness of life (Gudinas & Acosta, 2011). These concepts captured particular attention as they were each used to inform the new constitutions of

Ecuador in 2008 and Bolivia in 2009. Although the idea of *buen vivir* merits a much more in-depth discussion to do it justice, suffice to say that some of core concepts that are shared in most formulations of *buen vivir* highlight importance of nature, community, labour, consensus, democracy, reciprocity and spirituality as key components of individual and community well-being (Villalba, 2013).

In this dissertation I use the definition of human well-being put forth by the MEA (2003), which echoes some of Narayan's work but it explicitly links well-being with ecosystem services. The MEA (2003) defined well-being as encompassing five dimensions: material wealth, health, safety and security, good social relations, and freedom of choice and actions, which emerges from obtaining the four previous components of well-being. Within the context of the MEA, it is understood that human well-being emerges as an outcome of, and supported by, a variety of goods and services flowing from natural ecosystems. While the MEA makes explicit the reliance of humans on their natural environment, it is important to note that ecosystem services alone do not fulfill every human need and that some dimensions of well-being have only a superficial link to the environment, e.g. the need for social inclusion (Butler & Oluoch-Kosura, 2006, Fisher et al., 2014).

Rationale for Manuscripts

I have developed three lines of inquiry exploring the interplay between human well-being, ecosystem services and environmental management that form the basis for the manuscripts contained in this dissertation. Each manuscript considers the above themes from slightly different angles (see figure 1-12). I present the manuscripts in the order in which they were written because the perspective that informs each article is partially a reaction to the

findings and unanswered questions that emerged after writing the previous one. In this sense, the three manuscripts capture the evolution of my thinking about ecosystem services and human well-being. Briefly, the first manuscript is very much in line with the type of assessment that flows directly from the MEA (2003) framework. That is, I started from the assumption that ecosystems produce ecosystem services that benefit people. Because I wanted to include a participatory dimension to the assessment, I used photovoice to invite residents in a pineapple community to think about how ecosystems shaped their well-being. During this time I was seeking to gain a community-level perspective on what aspects of the natural environment contribute to the well-being of local agricultural communities. The second manuscript was motivated partly by the insights of the photovoice assessment that showed that the benefits that people derived from their ecosystems were highly contingent on the form of environmental management and governance associated with the production of those ecosystem services. Hence, the second manuscript centers on the system of production used in the Bribri Indigenous Territory to produce plantains. This article pays close attention to the type of access that plantain farmers experience as producers of ecosystem services and how access is regulated by power relationships. The third manuscript starts from the opposite end of the equation, that is, instead of starting with ecosystems, it starts with human well-being. The manuscript considers how well-being in banana and plantain agricultural communities is shaped by the ecosystem services that are produced and by how these are managed, paying particular attention to the impact of trade-offs between provisioning and regulating services.

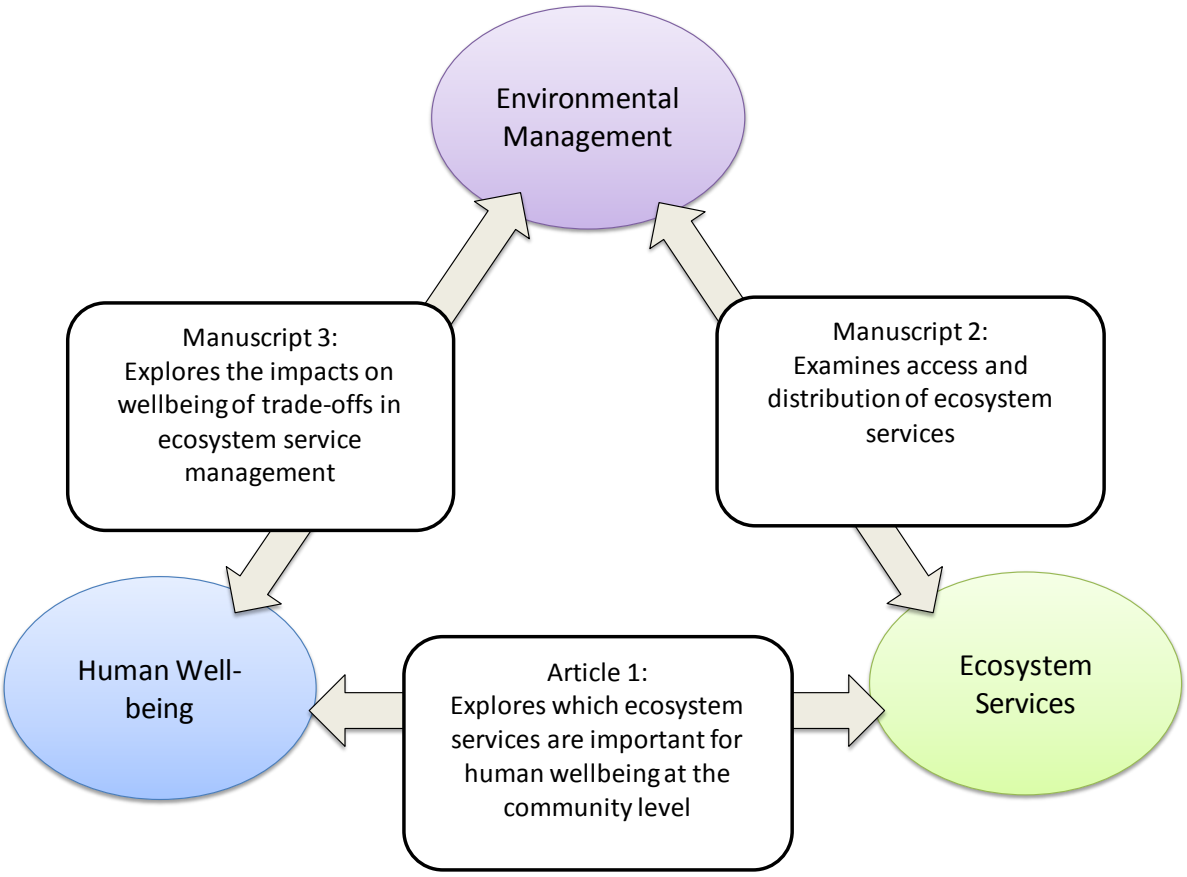

Figure 1-12. Diagram representing the different theoretical contributions of the three manuscripts that compose this dissertation

Article 1[1]- A participatory assessment of ecosystem services and human well-being in rural Costa Rica using photo-voice

In exploring the link between ecosystems and human well-being, I wanted to understand how people's personal circumstance influenced what they considered to be ecosystem services and how they benefited from their production. Hence, my point of departure was to experiment with the use of participatory methodologies to conduct a

[1] Article published as: Berbés-Blázquez, M. (2012). A participatory assessment of ecosystem services and human well-being in rural Costa Rica using photo-voice. *Environmental management*, *49*(4), 862-875.

community-level assessment of ecosystem services in one of the research sites to gain a perspective of the ecosystem services that were important for people's well-being. In part, this was motivated by the fact that a lot of the work on ecosystem services focuses on the objective assessment and classification of environmental functions. Yet, just because an ecosystem service is produced, it does not mean that it benefits someone. For example, an agricultural landscape that produces wheat (a provisioning ecosystem service) is of no use to a celiac who is unable to digest gluten; likewise, a river that might provide recreational opportunities (a cultural ecosystem service) is of no benefit to those who have no docking access.

The article is a product of my initial field season in the community of Volcán de Buenos Aires in Southwestern Costa Rica, which depends on the production of pineapples for export. I used photovoice —a method from the participatory action research tradition that relies on photographs taken by participants to guide discussion around a topic of interest. The stated goals of photovoice are: First, to enable communities to identify strengths and concerns; second, to promote critical dialogue around key issues; and third, to affect policy (Wang and Burris 1997; Wang et al. 1998). The application of photovoice techniques to questions of environmental management has been limited and, at that time, visual methods were altogether absent from the literature in ecosystem services. I saw in photovoice an underused methodology with the potential to complement more traditional expert-led ecosystem service assessments in the context of impoverished and resource-dependent communities. In particular, I thought that photovoice could be a vehicle for integrating the knowledges of diverse stakeholders and for exposing the complexity of social-ecological interactions.

In terms of examining the link between ecosystem services and the different dimensions of human well-being, my analysis showed that residents associated provisioning

ecosystem services with satisfying the material necessities of life; regulating ecosystem services with their health and safety (in the sense of living in a predictable environment); and cultural services with their health and with building good social relations. However, it also became evident that there was a discrepancy on how I originally conceived of ecosystem services (informed by the MEA framework) and what community members identified as the natural processes that benefitted, or harmed, them. For instance, sometimes the same crop was classified as both a provisioning and a cultural ecosystem service. This led me to propose a distinction between ecosystem services and ecosystem benefits to capture the fact that the same ecosystem service, e.g. pineapples, could be seen to produce several benefits depending on the group to which a person belonged, e.g. Pineapples can provide a monetary benefit for plantation workers or a nutritional benefit for pineapple consumers. Last, in this article I reflect on the opportunities and drawbacks of using a visual, participatory methodology to conduct an ecosystem service assessment.

Manuscript 2[2]- An analysis of access to ecosystem services in a plantain agricultural system: What lessons for poverty alleviation and sustainable development?

The idea advanced by the MEA (2003) that human well-being depends on ecosystem services has served well as a departing point and for illustrative purposes. However, when considering well-being at local scales its simplicity is deceiving, that is, the production of ecosystem services might not result in increases in human well-being in a straightforward manner. The contrast is especially striking in the case of agricultural communities who might be involved in maintaining high levels of production of provisioning services without

[2] This manuscript was presented at a workshop organized by the network on Power Relations and Ecosystem Services (PORES) in Seville (Spain) on October 2014.

experiencing the benefits, experiencing only partial benefits, or actually experiencing a decline in their well-being. Hence, in the context of poverty alleviation, there is a need not only of enhancing the ability of ecosystems to produce ecosystem services in a sustainable manner, but also of ensuring that there are mechanisms by which those ecosystem services become benefits at the local scale. This is why questions of access, distribution and personal circumstance that mediate the transformation of ecosystem services into ecosystem benefits are critically important (Daw et al., 2011).

When considering human well-being in agricultural communities it soon becomes evident that the production of ecosystem services does not necessarily translate into benefits at the local level. Instead a host of social processes mediate how and who benefits. These processes can be uncovered by considering the organization of environmental management associated with the production of a given crop. In the second manuscript I conducted a community-level analysis of the mechanisms by which access to ecosystem services is gained, maintained, and controlled in two communities in the Bribri Indigenous Territory that produce plantains for sale in the national market. In the manuscript I examine two alternative agricultural management systems that co-exist in the Bribri Indigenous Territory: One is the agroforestry system that relies on traditional Bribri practices, whereas the other agricultural system involves more intensification and relies on conventional agrochemical inputs to different degrees.

I conducted my analysis based on qualitative interviews geared to uncover the mechanisms that operate to grant and control access to different aspects involved in the production of plantains, for instance, access to land, markets, information, technology, credit, and labour opportunities (based on Ribot & Peluso, 2003). What the analysis demonstrated is

that each agricultural system produces a particular web of access, but that the conventional system of agriculture concentrated power in the hands of middlemen. Middlemen are people who come from outside of the territory to purchase the plantains and bring them to the market in the capital. I also characterized in the article the forms of power used by these gatekeepers to maintain access and finish by exploring the implications in terms of poverty alleviation and potential avenues for change.

Manuscript 3[3]- Trade-offs in ecosystem services, trade-offs in human well-being: Exploring the impacts of environmental management priorities on the well-being of agricultural communities in Costa Rica

The motivation behind this manuscript is that while the general links that the MEA (2003) framework proposes hold, there is still a need to better qualify and quantify the linkages between ecosystem services and the dimensions of human well-being, what they mean in different contexts, and for different stakeholders (Daw et al., 2011; Sandhu & Sandhu, 2014; de Oliveira & Berkes, 2014). Thus, the third manuscript focuses squarely on human well-being and it works its way back to tease out the points of intersection with the ecosystems that maintain it. In addition, the manuscript considers how alternative forms of resource management produce different bundles of ecosystem services and how this might ultimately impact human well-being. In particular, I was interested in comparing well-being across regions where environmental management had optimized a reduced range of ecosystem services (such as large-scale plantations) with regions where environmental management considered a range of ecosystem services (such as agroforestry). The reason being that the

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[3] A preliminary version of the results was presented as an oral presentation entitled "*Unpacking poverty in agricultural communities in Costa Rica based on ecosystem management priorities"* at the Resilience 2014 conference in Montpellier (France).

choices embedded in the different modes of agricultural management carry implicit trade-offs between ecosystem services that are often overlooked.

I approached this exploration using fuzzy cognitive maps (FCMs), which are arrow diagrams representing causal links between factors. I interviewed farmers, plantation workers and their families in three sites: the large-scale banana plantations in Matina that produce bananas for the international market, and two communities that practice smallholding agriculture in the Bribri Indigenous Territory where two alternative resource management systems coexist, traditional agroforestry plots that produce a variety of crops and single-species plots of plantain. Plantain from the Bribri Indigenous Territory is sold in the national and international markets.

The three manuscripts will be presented after chapter 2, which contains an expanded version of the methods of inquiry used in this dissertation. Chapter 3 contains the first manuscript (article) using photovoice to understand perceptions of ecosystem services in Volcán. Chapter 4 contains the second manuscript that explores power relations in the Bribri Indigenous Territory. Chapter 5 contains the third manuscript, which explores the impact of environmental management on the well-being of three resource-dependent communities in the Caribbean coast of Costa Rica. Finally, chapter 6 contains conclusions drawn from the entire dissertation and outlines possible directions for future research.

Chapter

2. METHODS OF INQUIRY

The approach to inquiry that I followed is best described as mixed methods (see table 2-1) namely, photovoice, interviews, field observation, and fuzzy cognitive maps (FCMs). These methods, particularly photovoice and FCMs, seldom have been used in relation to ecosystem services but, precisely because of this, they have the potential to bring out new insights. Each manuscript focuses on a different agricultural region of Costa Rica and explains the results of using a particular combination of methods (see figure 2-1) The first article uses photovoice and it is based on research done with pineapple-producing communities in the South-Pacific side in 2009. The other two manuscripts are based on research done in 2011 on the Caribbean coast of Costa Rica. The second manuscript relies on key informant interviews, semi-structured interviews and field observation in the communities of the Bribri Indigenous Territory. The third manuscript uses fuzzy cognitive maps and it focuses on the Bribri Indigenous Territory as well as communities surrounded by banana plantations in Matina.

Table 2-1.
Mixed Methods Employed In This Study and Selected Key References

Method	Description	Key references
Photovoice	11 transect walks and corresponding focus groups conducted with agricultural workers and their families regarding ecosystem services	Wang and Burris (1994, 1997), Wang et al., (1998)
Fuzzy cognitive maps (FCMs)	118 fuzzy cognitive maps constructed with farmers, agricultural workers and their families regarding their livelihoods.	Özesmi and Özesmi (2003, 2004), Kok (2009), van Vliet et al. (2010)
Key informant interviews	18 semi-structured interviews conducted with key informants regarding ecosystem management.	Patton (2002)
Field observation	Conducted at the local level over varying amounts of time to gain insights on people's livelihoods and ecosystem management.	Patton (2002), Mason (2009)

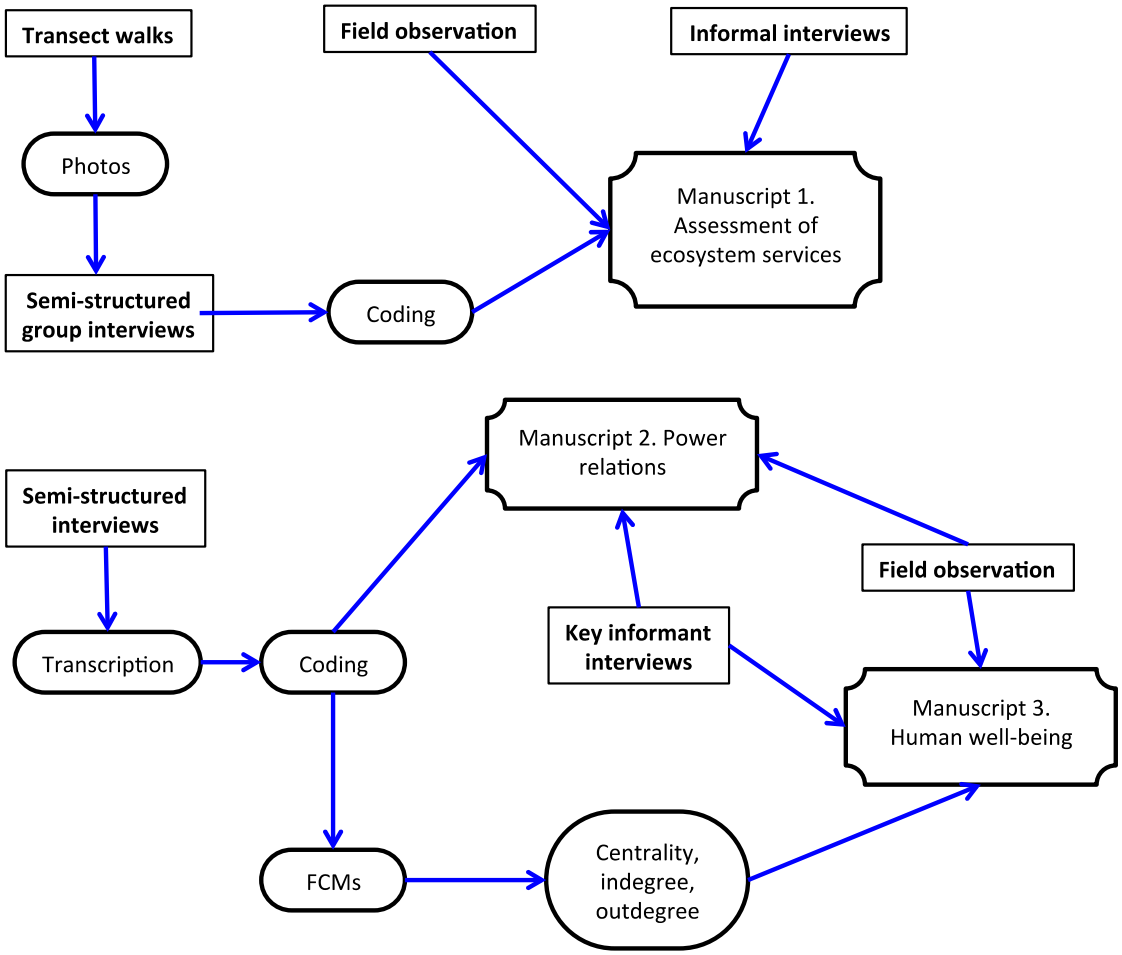


Figure 2-1. Flow chart of methods used to construct each manuscript. In square boxes are the data collection activities, in rounded boxes are the data treatment and analysis activities.

The choice of research sites reflects the evolution of my research interests as well as the different opportunities for collaboration that emerged throughout the duration of my degree. My initial interest in Costa Rica arose through my involvement with the Las Nubes program in the Faculty of Environmental Studies. Among other things, the program organizes field courses and it facilitates research in the Alexander Skutch Biological Corridor (ASBC), situated near the town of San Isidro (Puntarenas). The ASBC comprises the area between two ecological reserves, the Las Nubes cloud forest reserve and the Los Cusingos bird sanctuary. Communities in the corridor depend on small-scale coffee and sugar-cane farming. Following my

involvement with the Las Nubes program, I was invited by my dissertation supervisor to explore Volcán, a community that is only an hour away as the crow flies but dominated by large-scale pineapple agriculture. Dr. Bunch had been invited to the community by an expatriate who had an interest in attracting researchers to explore the impact of this form of agriculture on the environment. Whereas there were many students working in the ASBC, there had been relatively few researchers, national or international, involved in Volcán. This was due to the fact that the presence of the pineapple company had polarized the community during the 1990s leading to bitter encounters between those who opposed the pineapple expansion citing environmental and health concerns (but whose livelihoods depended to a large degree on cattle) and those who were newcomers to the community and depended on the jobs that the company provided. In addition, pineapple agriculture at the scale that is practiced in Volcán is relatively new in Costa Rica and its impacts are just beginning to be understood. I arrived to Volcán in 2009 for my first field season. At this time, I was interested in understanding how people related to their ecosystems in a broad sense. During the 2009 field season I was invited to the Central American Institute for Studies on Toxic Substances (IRET, Spanish acronym) in Heredia which has a long tradition of using an ecosystem approach to explore environmental and health interactions, with a focus on the impacts of large-scale agriculture on human health. In a subsequent visit to Costa Rica in 2010, I followed the IRET team to the regions of Matina and Talamanca to gauge the possibility of developing a research collaboration. At this point, the IRET had wrapped up a study conducted with Indigenous children in Talamanca testing their exposure to pesticides used in plantain and banana agriculture using an ecosystem health approach (see Barraza et al. 2011; van Wendel de Joode et al., 2012) and they were starting to collect data for their new program on Infants and Environmental Health (Infantes y Salud Ambiental (ISA, Spanish acronym). The ISA study (www.isa.una.ac.cr) is a prospective

community-based birth cohort study to examine the effects of prenatal and early life pesticide and manganese exposures on children's growth and neurodevelopment in Matina, Limón (Mora et al., 2014; van Wendel de Joode et al., 2014). In addition, pathways of exposures and risk perception of pesticides are being studied (Barraza et al., 2011; Barraza et al 2013).

Hence, at this point, I was familiar with four different regions in Costa Rica that were rural and depended on agriculture but each with a distinct character that, I suspected, was tied to its system of agricultural exploitation. This is how the idea of exploring the impact of environmental management on human well-being began to form. I secured external funding for a longer field season in 2011, in which I conducted the research that supports the second and third manuscripts. Between June and November 2011 I, and three research assistants, conducted over 200 interviews with agricultural workers and farmers living in the ASBC, Volcán, Matina and the Bribri Indigenous Territory (Talamanca). I was lucky to count with enormous amounts of "research social capital" that allowed me to quickly get to work, move around in the country and coordinate the data gathering. The reason why the interviews from Volcán and Las Nubes are not included in the third manuscript is that their quality was more uneven and not comparable to the data set obtained from Matina and the Bribri communities.

I now describe in turn each method, as well as the data collection and data analysis associated with that particular part of the dissertation. A similar or an abbreviated version of these methods is included in each manuscript.

Photovoice

Photographs and other visual tools have been integrated in social science research in a variety of ways. Early anthropologists used photographs for documenting social or cultural

phenomena. In 1967, John Collier coined the term “photo elicitation”, which consisted of using photographs as props during interviews to stimulate and guide responses, effectively creating the field of visual anthropology (Harper, 2002). Variations of photo elicitation have been adopted in psychology, education or organizational studies (Hurworth, 2004). The underlying idea is that images are more effective in evoking experiences and insights than spoken or written words alone (Carlsson, 2001; Harper, 2002). In photo elicitation, the researcher usually provides the pictures upon which the participants comment, by contrast, in photo novella and photovoice, research participants take their own photographs. Photo novella and photovoice share similar origins, but photo novella focuses on having participants tell their stories by photographing their everyday lives (Wang & Burris, 1994), whereas photovoice is a process by which “people can identify, represent and enhance their community through a specific photographic technique” (Wang &Burris, 1997, p.369). Hence, the storytelling element is less central in photovoice.

Photovoice is theoretically situated within the fields of education for critical consciousness, feminist theory and documentary photography. Following Paolo Freire’s approach for critical education, photovoice uses the pictures taken by the participants to create “coded situation problems”, that is, abstractions that allow people to reflect upon their own realities (Wang & Burris, 1994). Photovoice also emphasizes praxis - the combination of reflection and action to promote change (Freire, 1970) - by entrusting cameras to people so that they become active agents in transforming their reality. From feminist theory, photovoice considers the power dynamics and biases that exist in participatory research and it intends to become a vehicle for disempowered and hard-to-reach groups that include women but also children, peasants, the illiterate or any stigmatized population (Wang & Burris, 1994). Finally, the idea behind documentary photography is to capture in pictures socially relevant

phenomena (Wang & Burris, 1994). In the case of photovoice, participants determine what phenomena are important, thus providing an insider perspective into an issue. These theoretical foundations underlie the three goals of photovoice, which are: to enable communities to identify their strengths and concerns; to promote critical dialogue around key issues; and to affect policy (Wang & Burris, 1997; Wang et al., 1998).

Photovoice has been applied to participatory needs assessments in the study of a range of issues such as health (e.g. Wang et al., 1998; Carlsson, 2006; Catalani and Minkler, 2010), homelessness (e.g. Dixon & Hadjialexiou, 2005; Rhodes et al., 2008), stigmatized groups (e.g. Graziano, 2004; Hussey, 2006) and disability (e.g. Jurkowski & Paul-Ward, 2007; Thompson et al., 2008). Yet, the application of photovoice techniques to questions of environmental management remains limited (some exceptions are Bosak, 2008; Castleden et al., 2008; 2009) and it is altogether absent from the literature in ecosystem services, even though some authors have used other participatory techniques, such as participatory rural appraisal and rapid rural appraisal, in assessing ecosystem services (e.g. Pereira et al., 2005).

Data Collection for Photovoice

Sampling. Because photovoice is a participatory methodology, data collection for this part of the project was voluntary. I organized a community meeting to which everyone in Volcán was invited to attend and to which about 80 residents came. There I presented the research goals and asked for volunteers for the photovoice exercise. In selecting volunteers, no one was turned down and no one was specifically asked to participate. This choice resulted in a sample that did not correspond to the demographic characteristics of the region. Notably males and workers from the Pineapple Development Company (PINDECO) were underrepresented.

This is partly due to the long workday in the plantations and partly due to fear of reprisals by the company.

Transect Walks. The actual photovoice exercise combined photovoice with a modified transect walk. Each group of 2-4 volunteer participants, e.g. young females from a given neighborhood, met with me separately. The participants agreed among themselves on a route within the geographical limits of the Volcán River watershed, which usually took between 3 to 4 hours to walk. In choosing the route, there were no specific instructions given or requests made to participants, other than the routes should allow for the exploration of ecosystem services that affected the participants' well-being positively or negatively. While the region is rural – communities are made up of neighborhoods of 20-30 households surrounded by pineapple fields – participants often chose routes some distance away from their neighborhoods and that contained natural features, such as a creek. All participants were shown how to use a digital camera and two cameras were provided for them to take pictures during the transect walk. They were asked to take pictures of ecosystem services that affected their health and well-being, in positive or negative ways. Prior to the start, the meaning of the term 'ecosystem service' was revisited and a handout with examples was given to them for reference. Depending on the group, less technical terms, such as 'environment' or 'nature', were used interchangeably with ecosystem services. During the walk, participants were encouraged to adopt the role of guides in interpreting for me how the ecosystem and the changes in the landscape affected their well-being and to take as many pictures as they wished. In total, I conducted 11 transect walks in which 34 people participated.

Semi-structured group interviews. At a later time, each group met separately with me to discuss the photographs taken during the transect walk. I followed a semi-structured

format modeled after McIntyre (2003) to encourage participants to explain what the photographs meant to them. I used open-ended questions probing participants to reflect on what the ecosystem service represented in each image meant for their well-being. I also found that asking participants to choose among the 60-70 photographs that they usually took during the transect walk evoked more personal responses. Hence, after participants had discussed all of the pictures I asked them to prioritize the photographs that depicted the ecosystem services that were more important to their well-being. If the group had 2 people they could choose up to 5 photographs, if the group had 3-4 people they could choose up to 10. This often brought insights into how the participants conceived of the relationships between the different ecosystem services and also hints of what participants considered acceptable, or unacceptable, trade-offs between ecosystem services. These conversations were recorded and transcribed with their permission. After completing this part, there were 65 pictures of ecosystem services in total that represented 76 benefits, or impacts, according to participants. Since there was repetition among the pictures selected by the different groups, I pooled them into 21 common themes.

Data Analysis for Photovoice

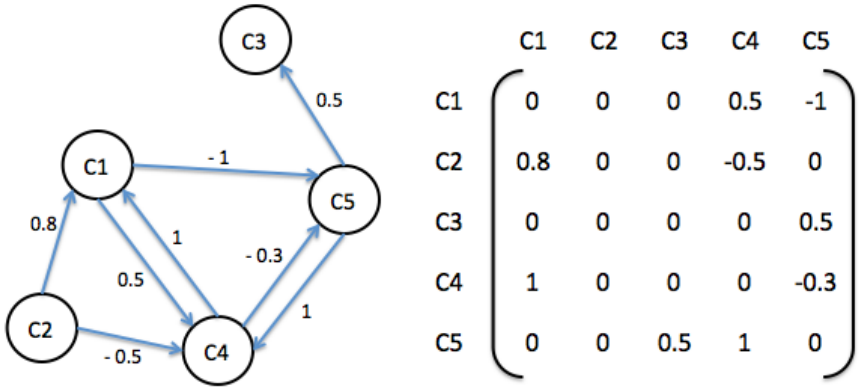
I interpreted the results from the small group discussions according to the MEA (2003) framework to classify ecosystem services and their effect on human well-being. For instance, a group of participants said about a picture depicting a cart loaded with cut sugarcane: *"This is sugarcane. We think it is good because it brings money. But it also brings chemicals and who knows what, which are bad […] We also make a lot of desserts from sugarcane like 'sobaos' and 'agua dulce' "*. Hence, I classified sugarcane as a provisioning service (after MEA 2003 and TEEB 2010), and based on their explanation, I gathered that participants associated sugarcane negatively with the deleterious health effects of agrochemicals, and positively with increasing

their material welfare and giving them a sense of identify that comes from making traditional Costa Rican foods. Although I originally intended to uncover possible correlations between particular stakeholder groups in the watershed and the ecosystem services that affected their well-being, the small sample size prevented me from applying statistical tests.

Fuzzy cognitive maps

Axelrod (1976) developed cognitive maps in the 1970s when he used arrows to relate causal concepts that represented political decision-making processes. In 1986, Kosko introduced the term fuzzy cognitive map by assigning weights to the arrows in Axelrod's maps. Hence, an FCM is a graphical representation of causal links that allows the study of how an effect propagates forwards and backwards throughout a causal chain (Kosko, 1986). As such, FCMs are versatile tools commonly used for: explanation, to describe observed behaviour; prediction, to anticipate future system behaviour; reflection, to invite deliberation on current understandings of a system; or in a strategic manner, to improve the descriptions of a situation. FCMs are useful in describing complex system dynamics and in the past decade they have found application in engineering, behavioural sciences, production systems, business, environment, agriculture, education, medicine, information technology and telecommunications (Papageprgiou & Salmero, 2012). In the environmental realm, FCMs have been used to map local knowledge in participatory processes (Özesmi & Özesmi, 2003; Özesmi, 2006; Isaac et al., 2009; Rajaram & Das, 2010), the study of stakeholder processes and conflict (Özesmi & Özesmi, 2004; Giordano, 2010; Kafetzis et al., 2010), modelling and hypothesis testing (Kok, 2009; Ramsey & Norbury, 2009; Soler et al., 2012), communication and learning (van Vliet et al., 2010), and to study vulnerability to environmental change (Murungweni et al., 2011).

A FCM contains vertices or nodes, Ci, Cj… Cn, which represent variable concepts, such as the stability of crop prices or exposure to agrochemicals, that are connected by links called edges or arcs. If an edge is identified with a positive sign, it means that more of Ci causes more of Cj (direct relation), and if the edge is identified with a negative sign, it means that more of Ci causes less of Cj (inverse relation). A number between −1 and +1 indicates the strength of the connection, the larger the number, the stronger the connection. Note that the relations depicted in FCMs express believed causality, not probability, the causality between two node variables is taken at face value as the maps are constructed to capture expert opinion about an issue (Carvalho, 2012). In this case, those living in agricultural communities, farmers, agricultural workers and their families are the experts in determining what affects their well-being. The graphical depictions of FCMs can be transformed into an adjacency matrix such as the one shown below (figure 2-2). Individual adjacency matrixes can be added to create an augmented matrix that reflects the opinion of a group of experts, e.g. female banana workers (Kosko, 1988). Once the FCMs are constructed, it is possible to use basic graph theory concepts, such as centrality, indegree and outdegree, to analyse the relative importance of the relationships identified. The outdegree is the sum of all the absolute values within a row of the matrix, that is, the absolute sum of all of the weights of the arrows going out of a node. The indegree is the sum of all the absolute values in a column, that is, the absolute sum of all the weights of the arrows coming into a node. Centrality is the absolute sum of indegree and outdegree. In the hypothetical FCM shown below, node C1 has an outdegree of 1.5, an indegree of 1.8 and a centrality of 3.3.



	C1	C2	C3	C4	C5
C1	0	0	0	0.5	-1
C2	0.8	0	0	-0.5	0
C3	0	0	0	0	0.5
C4	1	0	0	0	-0.3
C5	0	0	0.5	1	0

Figure 2-2. Example of fuzzy cognitive map and its corresponding adjacency matrix.

Some of the reasons that make FCMs attractive to explore well-being among agricultural workers and their families are: First, FCMs are particularly well suited for exploring soft-knowledge domains that have a qualitative, rather than a quantitative, emphasis (Kok, 2009). Second, they can integrate different types of knowledge and include a wide range of variables (Özesmi & Özesmi, 2004, van Vliet et al., 2010). Given the complex nature of human well-being as a subject matter and the diversity of interviewees, it was essential to provide a platform that would allow participants to express a wide range of topics pertaining to their well-being, as well as integrating variables that might go from the easily quantifiable, such as the price of coffee, to the more abstract, such as living according to Indigenous values. Third, FCMs highlight key feedbacks in the system, which when combined with resilience thinking, can provide insights into short-term and long-term social-ecological dynamics (Kok, 2009). This was important as I sought to gain a dynamic systems perspective of people's well-being, which includes understanding what are the shocks and disturbances to their livelihoods, what are the causal pathways that shape their realities, and what are the pathways that they perceive as unmovable. Fourth, they can serve as a communication and learning tool between groups of

stakeholders (van Vliet et al., 2010), which will be important to return results to the communities that participated in the assessment and to have them compare their communal FCM with those of other communities. Finally, although my approach was not participatory, others have found that FCMs are useful in participatory settings (Kok, 2009; van Vliet et al., 2010).

Some of the limitations of FCMs are: First, the methods used to come up with the weighting factors that quantify the strength of the relationships between variables tend to be the Achilles tendon of FCMs (Kok, 2009). In particular, when constructing FCMs from interview data, it is a difficult balance to reduce the richness of the data while conveying the complexity of the opinions expressed by participants. There are different ways of determining the weights of the arrows, each with its own advantages and disadvantages detailed on section 2.2.3 below. Second, there is no indication of time in FCMs (Carvalho, 2012). Indeed, when people talk about their well-being, they tend to refer to several temporal scales simultaneously, e.g. Monthly payments, yearly floods, daily routines, long-term goals. If one were to use the information in the map to run a simulation, it would be important that all variables be adjusted so that they change following the same time step, but for the purposes of my work, the relations identified in the map are true in an abstract sense.

Data Collection for Fuzzy Cognitive Maps

Sampling. I used stratified purposeful sampling to select participants in Matina and the Bribri Indigenous Territory. Purposeful sampling provides in-depth information about a relatively small number of cases selected purposefully, as opposed to random sampling, which aims to be statistically representative (Patton, 2002). I sought a stratified sample by considering the possible differences on perspectives that might be held by distinct

demographic groups within each of the study sites, e.g. Across gender lines, country of origin, traditional farmers vs. conventional farmers, etc. (see table 2-2). This approach allowed me to explore the uniqueness of particular demographic groups, as well as to investigate shared patterns that might cut across those demographic lines. Practically, we used snowball sampling in all study sites, that is, we had local contacts that pointed us to initial interview candidates, after which we asked interviewees to point us to a person who would produce a similar map to theirs, and to another person who would produce a different map to theirs. When constructing FCMs, Özesmi & Özesmi (2003) recommend stopping after the answers begin to converge, that is, the same themes are repeated in response to the interview questions. Given that I was not able to listen to all of the interviews while I was in the field, I instructed the research assistants to aim for at least 10 people per demographic group.

Table 2-2.
Description of Demographic Groups Sought in Each Agricultural Region

Agricultural Region	Relevant Demographic Categories	Group Description
Banana plantations	Female plantation workers	Female banana plantation workers, usually employed in packing plants. Most are Costa Rican, many are single heads of households.
	Female housewives	Spouses of plantation workers who are housewives or might take odd jobs (sewing, etc.). Mostly Costa Rican.
	Male plantation workers (Costa Rican)	Costa Rican male banana plantation workers, usually employed as field workers.
	Male plantation workers (Nicaraguan)	Nicaraguan male banana plantation workers, usually employed as field workers, sometimes through a subcontractor. Many are/had been illegally in the country.
Traditional and conventional plantain/ banana/ cocoa farms	Indigenous female producers (Suretka/Shiroles)	Indigenous Bribri women whose livelihoods depend on the production of plantain and banana. Some use traditional methods, some use conventional methods.
	Indigenous male producers (Suretka/Shiroles)	Indigenous Bribri men whose livelihoods depend on the production of plantain and banana. Some use traditional methods, some use conventional methods.
	Indigenous female producers (Amubrë)	Indigenous Bribri women whose livelihoods depend on the production of plantain/banana/cocoa. Most use traditional methods. Amubrë is not accessible by car.
	Indigenous male producers (Amubrë)	Indigenous Bribri men whose livelihoods depend on the production of plantain/banana/cocoa. Most use traditional methods. Amubrë is not accessible by car.

Semi-structured interviews. The FCMs used in this research are based on semi-structured interviews conducted between August and November 2011 by three field research assistants and myself. All of the assistants were fluent in Spanish and one of them was Costa Rican. I provided individual training for each field assistant on how to interview and how to construct the FCMs with the participants for at least one week. After the first week of training, assistants were working independently in their region, although we were in communication via phone and I visited each study site approximately every two weeks.

At the start of the interview, the interviewer administered a short questionnaire (see appendix A) to the participant. This questionnaire was intended to obtain basic demographic information (gender, age, country of origin, Indigenous membership) and some indication of socio-economic status (occupation, % of income dependent on agriculture, land ownership and size). These categories were used to contextualize and to explore potential differences in participants' perceptions of human well-being. The interviews were conducted one-on-one with farmers, agricultural workers and their families using a semi-structured format. Semi-structured interviews have been defined as "conversations with a purpose" (Mason, 2009), so they were fairly informal exchanges with the idea of encouraging the person to adopt a biographical, narrative approach to identify the relations that shaped their well-being. After explaining that we wanted to construct with them a "map of ideas" (*mapa de ideas*), the interviewer began by asking the person what they needed to feel well. Once, they gave an initial answer, e.g. a stable job to have a source of income, the interviewer questioned the person further with probes to elicit further elaboration, for instance, *"and what does having a stable job depend on?", "how come?"* and so on. We insisted on probing questions that highlighted dependency because it was a way to get people to think about causality. We were particularly interested in hearing their thoughts with respect to material wealth, safety and security, health,

social relations and environmental concerns. Most interviewees covered at least a few of these dimensions on their own, but if they did not, the interviewer would ask them specifically about them. I have included a sample of the interview questions in appendix A, however, interviewers had some latitude to use other questions that would get the person to talk about the different aspects of well-being.

As the participant started to speak, the interviewer began constructing the FCM on a large piece of paper that was visible to the interviewee. The interviewer wrote the concepts that were mentioned and drew arrows to indicate how one variable affected another one. For instance, if the person mentioned that their material well-being depended on the price of a crop, the interviewer drew an arrow linking *"price of plantain"* to *"material well-being*" with a "+" sign. There was constant checking in with the interviewee to ensure that the relationship identified in the FCM was indeed what they had meant to say. However, the level of engagement with the actual map varied, sometimes, the person pointed to the map and explained the interactions, other times, the person spoke to the interviewer directly without referring much to the map. An example of a finished map is shown in figure 2-3.

Initially, we tried to get participants to assign weights to the edges of the FCM, that is, a number between 0 to 10 depending on how much that particular relation affected their well-being. However, it soon became evident that people had a very hard time saying that something was "less important" when it came to their well-being, hence we often ended up with maps that had 10s (very important) for all of the relationships identified. The process also took significantly more time as many interviewees seemed uncomfortable assigning numbers even when we used a rating scale that went from "a lot - 10" to "a little - 1". Therefore, in later maps we simply asked them to assign polarity without assigning weights. To finish the interview, the

interviewer summarized the relations identified in the map and asked the person if they agreed or if they wanted to add, or remove, something. The interview concluded when the person did not have anything else to add. Typically interviews lasted 30 minutes, the shortest interviews lasted approximately 15 minutes, the longest ones went on for over an hour. With their consent, interviews were recorded and a digital photograph of the FCM taken.

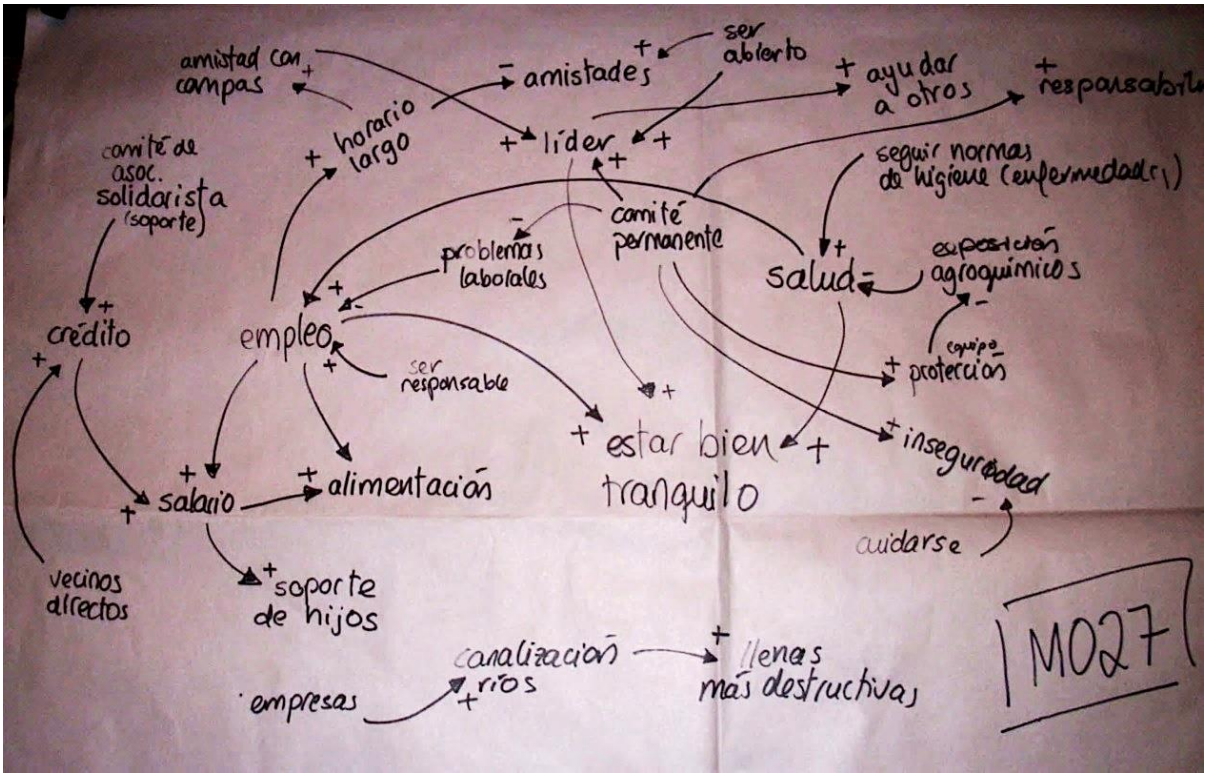


Figure 2-3. Example of fuzzy cognitive map completed during an interview with a Nicaraguan male worker in B-Line (Matina)

Data Analysis for Fuzzy Cognitive Maps

Initially I intended to use the maps that were drawn with the participants based on the photographs. However, I noticed that when looking at the maps that I had not done myself, I had a difficult time interpreting the stories behind them, especially when a map showed counterintuitive links. For instance, if a map showed an inverse relation between a "family" and "feeling safe", it was hard to assess whether the polarity was a mistake made by the field

assistant or if it was a case where the person was suffering domestic abuse. Another concern was about lead-in questions, as it is impossible to discern the degree to which a person's answer might have been influenced by the way that the question was posed. Therefore it was more accurate to redo the maps based on the interview recordings. Unfortunately, this meant that between corrupt sound files, recordings with high ambience noise levels, and having had an unusually high number of interviewees in Matina who did not feel comfortable being recorded, 26 FCMs (out of 93) could not be reproduced, leaving a total of 67 maps.

Transcription. Recorded interviews were transcribed and these transcripts formed the basis of the FCM analysis. I transcribed 59 interviews and a volunteer assistant, who is also a native Spanish speaker and is familiar with the project, transcribed the remaining 8 interviews. I chose to do non-verbatim transcription given that my analysis focuses on the content of the interviews rather than on how participants expressed themselves. This means that conversation fillers such as "eh", "hmm" or "diay" are not necessarily always included in the transcripts; the only non-verbal communication cues included in the transcripts were if the person laughed or cried because it added important contextual information that helped interpreting their statements; there was no editing of slang, idioms nor localisms; pauses and silences in the conversation are noted in the transcript by "…" without indicating their duration. While listening to the interviews, I kept observations on the quality of the interview, that is, I noted to what degree the interviewer might have influenced the response with lead-in questions; I listened for cues about the level of engagement and comfort of the interviewee, e.g. if the person seemed silenced, distracted, contrite or emotional; and about the environment in which the interview took place, e.g. if others were present in the room or if the interview was interrupted.

Constructing FCMs. I explored two ways of creating FCMs based on the qualitative analysis of interviews. The first way is to construct an individual person's FCM by drawing the relationships that the person establishes during the interview and assigning to all edges the same weight, that is, +1 if it is identified as a direct relation and −1 if it is identified as an inverse relation. Once the FCMs for that particular demographic group are summed, new weights emerge that show higher absolute weights for the relationships that are more common to that group and lower absolute weights for those relations expressed by only one or a few individuals. The main advantage of constructing FCMs this way is that it is consistent with what the person expresses during the interview, reducing the amount of my own interpretation. That is, this method is consistent with the idea that FCMs are tools that capture the causality between variables as established by experts, as clearly, interviewees are best positioned to determine what influences their well-being.

The second way of constructing individual FCMs was for me to assign weights to the linkages expressed by individuals based on the range of collective experiences. For instance, most people expressed some degree of concern for their safety and when probed further, they would generally make a link between their safety and the incidence of crime in the community. However, on listening to the interviews I realized that the expectation, or the experience, of suffering bodily harm differed: for most people feeling unsafe was related to the potential for becoming a victim of petty crime in an abstract sense as they often had not experienced violence themselves. However, in one set of interviews people related their feeling unsafe to more violent crimes, not just petty crime, speaking instead of "shootings" (*balaceras*), and they talked concretely about having experienced violence themselves or within their immediate relations, e.g. having experienced a homicide in their community or in their family. Hence the same causal relation, that is, "as the incidence of crime increases, the feeling of personal safety

decreases", actually signifies different things in different contexts. This variation might then be expressed using a linguistic function such as the one depicted in figure 2-4. Note that the range is relevant to this set of interviews and that it would change had the interviews taken place in the Democratic Republic Congo or in Norway. The main, and important, disadvantage of the second approach is that the FCM reflects my assessment of the well-being expressed by participants, obscuring the connection between the weights and the interviewee's experience of their well-being. Upon consultation with Dr. Michael Bachhofer and Dr. Martin Wildenberg, from FCMappers, I chose the first method to construct the individual adjacency matrixes.

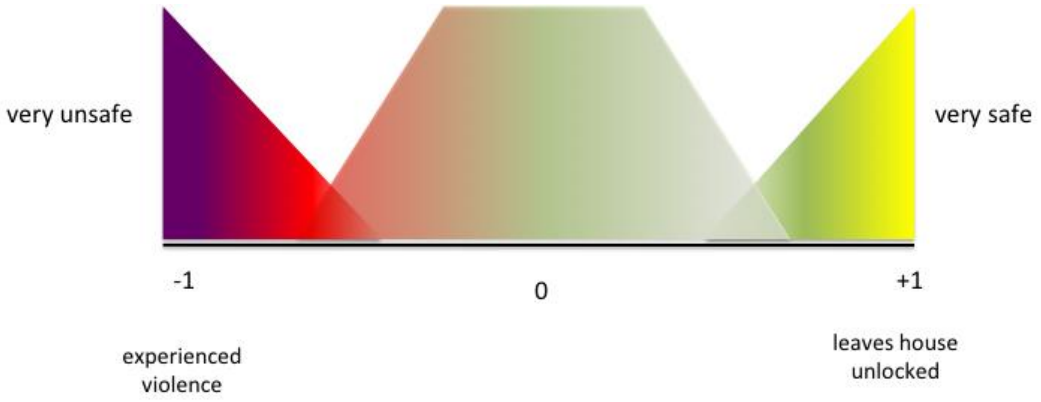


Figure2-4. Hypothetical linguistic function for the feeling of safety.

After creating the individual adjacency matrixes for each interview, I constructed augmented matrixes for each demographic group identified in table 2-2. To aggregate the weights of the individual matrixes I added the occurrences where a particular relation was identified across the group. I used the free software FCMappers (http://www.fcmappers.net), which is an Excel spreadsheet with built-in macros that allows the user to calculate FCM indexes from an adjacency matrix. The map indexes that interested me were: outdegree, indegree and the centrality. In an FCM that represents well-being, those variables that have higher centrality can be interpreted as most important for the person. Factors that have high

indegree could be something like “availability of work”, which is affected by many factors; whereas we might expect variables such as “insufficient salary”, which affects many factors, to have high outdegree. Last, I used Pajek, another free software for social network analysis, to visualize the FCMs and produce the FCM figures contained in this dissertation.

Key Informant Interviews

Key informants are people who are particularly knowledgeable and articulate about the study site and whose insights can be especially useful in interpreting what is happening and why (Patton, 2002). I conducted a number of key informant interviews in each region whose aim was to gain information about the resource management system in each agricultural site. In some regions I was able to determine key informants myself and in others I relied on the guidance and contacts of local researchers to find key informants. Some local researchers became informants as well. The number of interviews varied in each study site depending on my own familiarity with the setting and the amount of secondary data available on each (see table 2-3). There was no further manipulation or analysis done on the data as they were used as reference sources.

Table 2-3.
Roles and Positions of Key Informants Within Their Communities

Banana plantations	Pineapple plantations	Plantain/banana farms
1 Rep. women’s group	2 Reps from Asociación de Desarrollo	3 Agricultural co-op members
2 Reps from Asociación de Desarrollo*		2 Ex-reps from ADITIBRI‡
1 Researcher		1 Rep from ADITIBRI
		1 Elder
		1 Researchers

‡ADITIBRI: Indigenous Bribri government
* Asociación de Desarrollo: Local government in small communities

Field Observations

Field observations encompass a variety of techniques, which involve immersing oneself in a research setting to experience and observe first hand a range of dimensions in and of that setting (Mason, 2009). The observable events might include daily routines, interactions, relationships, events, norms, ways of doing things, or spatial arrangements. The reason for doing field observations is that some information cannot be articulated during an interview, instead in-depth, complex data might be revealed in other, more multidimensional ways (Mason, 2009). In addition, the researcher becomes better able to articulate certain understandings about a place once s/he has experienced it, while being mindful that his/her own positionality is always different from that one of other participants in that setting (Mason, 2009).

There is no prescribed way of doing field observations, and my own experiences in each study site have been different in terms of the time that I spent in each, where I positioned myself along the observer-participant continuum and the type of access I had to each community (see table 2-4). Field observations on the pineapple region came from living in the community of Volcán hosted by several families for a period of 3 months and subsequent shorter visits. Observations on the Indigenous territory came from short stays in the Finca Educativa (model farmstead) in the community of Shiroles and a visit to the community of Amubrë. Observations on the banana region came from living for a month in the community of Bataan in accommodations shared with local researchers, as well as previous shorter visits with the same research group. However, due to high levels of criminality in the area, field observations and engagement with the community were more limited there than anywhere else. In addition, the research assistants did their own observations while they lived in the

communities. Giselle Hausman spent three months in Volcán, Andrea Morales spent six weeks in Shiroles and Amubrë, and one month in Bataan. There was no further manipulation done on the field observation data as it was used to gain and contrast factual information about the agricultural regions.

Table 2-4.
Summary of Field Observations Opportunities for Each Study Site

	Banana plantations	**Pineapple plantations**	**Plantain/banana farms**
Time spent	1 month and short visits (1 week at time)	3 months and short visits (2 weeks at time)	Several short visits (1-2 weeks at time)
Participant – observer	Observer	Participant-observer	Observer
Types of community activities observed	Few. Visited women's project, observed nemagon meeting, street band rehearsal	Many. From civic committees to sport events.	Few. Training for eco-tourism guides. Visits to agricultural cooperatives.
Types of community spaces visited	Market, small restaurants	Market, churches, small restaurants, schools, soccer field	Market, small restaurants, soccer field
Access to family life	Only during interviews (houses and worker's quarters)	Lived with families	Only during interviews
Access to production sites	Very restricted. Observed plantations from the outside.	Easy access. Visited pineapple plots on my own. Guided visit to packing plant.	Easy access. Visited nearby farms on my own. Guided visits to model farms.
Availability of secondary data sources	Substantial	Little	Substantial

A Note on Coding

Coding is the process of searching, organizing and focusing large amounts of qualitative data to answer theoretical questions. Hence, coding has been an essential part of the data analysis in this dissertation, especially for producing the second and third manuscripts. Coding textual data serves several purposes: First, it helps to sort and categorize data (Charmaz, 1983; Saldaña, 2009); second, it serves to link raw data with theoretical concepts (Corbin and Strauss, 2008); and third, it facilitates retrieving text for analysis and comparison (Taylor and Gibbs, 2010). To code the semi-structured interviews that were conducted in Matina and the Bribri Indigenous Territory I started with a close read of the whole text (one interview at a time).

Then, I coded by hand using coloured pens large chunks of the text into initial categories based roughly on the dimensions of human well-being (material wealth, safety and security, health, social relations, freedom), ecosystem services (provisioning, regulating, cultural, supporting) and mentions of activities related to environmental management. This is sometimes called open coding in grounded theory (Charmaz, 2008; Corbin and Strauss, 2008) and the intention is to break data apart into large blocks to identify themes. These initial categories where mostly descriptive and aimed at capturing the essence of what the person was conveying, e.g. "flooding" or "work hours". In a practical sense, to obtain the initial categories I scrutinized the interviews looking for (Ryan and Bernard (2003):

- Repetition of words, expressions or sentences;
- 'Indigenous categories' or '*in vivo* codes', that is, local terms that might sound unfamiliar or regular terms that might be used in an unfamiliar way, e.g. Bribri plantain producers spoke of "the punishment" (*el castigo*) to refer to the economic loss that they incur when they are forced to sell a plantain bunch for half its price;
- Metaphors or analogies, e.g. some banana plantation workers likened their lives to "slavery";
- Linguistic connectors that might indicate a causal relation, e.g. "if", "then", "because", "since", "after", or "before";
- Missing data, e.g. When a person living near a plantation does not mention aerial spraying even though planes fly near their homes daily;
- Speech transitions such as pauses, silences or changes of topic.

On the second round, sometimes called focused or axial coding (Charmaz, 2008; Corbin and Strauss, 2008), the goal is to draw relationships between the blocks. For this round of coding I used Atlas.ti 7, a software specialized in qualitative data analysis, that allows one to

keep track of raw data, codes, quotations, and memos. During this phase of the analysis, I reviewed and compared the excerpts of the selected text performing what Glaser and Strauss (1967) call the "constant comparison method", which consists of continuously going back between excerpts to assess how similar (or different) they are from each other. As coding proceeded, I was able to group codes together, if they were similar, or to split them into categories if they were different. I used a combination of inductive and deductive logic to prepare the coding frames. That is, the frames were derived partly from categories that emerged following the first round of coding and partly from my own research questions.

In preparing the data for the FCMs shown in the third manuscript, I had to reduce the number of codes to add clarity to the maps (Nakamura et al., 1982). Again, this involved comparing text excerpts to ensure that they were similar enough to warrant creating a joint code. The ability to discern when two excerpts were "close enough" was gained through careful re-reading of the whole data set, which gave me a sense of the range of responss.

CHAPTER

3. A PARTICIPATORY ASSESSMENT OF ECOSYSTEM SERVICES AND HUMAN WELL-BEING IN RURAL COSTA RICA USING PHOTO-VOICE[4]

Human well-being is intricately connected to ecosystem services. Defined as the "conditions and processes through which natural ecosystems […] sustain and fulfill human life" (Daily 1997, p.3), the concept of ecosystem services resonates with ecologists, environmental managers and decision-makers as witnessed by the increasing body of work devoted to their study (Fisher et al. 2009). A keystone contribution to the ecosystem service literature has been the Millennium Ecosystem Assessment, MA, (2003, 2005), which introduced a new conceptual framework for understanding how environmental change affects ecosystem services and human well-being (Mooney et al. 2005). The MA divides ecosystem services into provisioning services associated with the supply of material goods (e.g. timber, fish); regulating services associated with the regulation of natural processes (e.g. climate regulation); cultural services associated with the nonmaterial benefits that humans might experience from their natural environment (e.g. recreational use, spiritual fulfillment); and, supporting services associated with the underlying ecological functions that sustain all others services (e.g. nutrient cycling). Similarly, the MA defined human well-being as a multidimensional concept encompassing

[4] Article published as Berbés-Blázquez, M. (2012). A participatory assessment of ecosystem services and human well-being in rural Costa Rica using photo-voice. *Environmental management*, *49*(4), 862-875.

material wealth, health, safety and security, good social relations, and freedom of choice and actions, which emerges from obtaining the four previous components of well-being (figure 3-1).

Much of the work on ecosystem services to date has focused on the assessment and classification of environmental functions. However, despite the intuitive appeal of the concept of ecosystem services and the impressive body of work in classifying natural functions at different scales, there is still a need to better understand the actual interplay between ecosystem services and the determinants of human well-being (Carpenter et al. 2009). In particular, how regulating and cultural services affect well-being remains inadequately researched and better conceptualizations and measurement tools are required (Raudsepp-Hearne et al. 2010a). The need is especially pressing in the context of resource-dependent communities whose livelihoods depend on a single, or a reduced range, of ecosystem services and are therefore more vulnerable to environmental change (Duraiappah 1998; Adger 2000). Recent suggestions to further refine the MA categories are a step in that direction, for instance, some classifications now distinguish between ecosystem services and benefits: Ecosystem benefits depend on services but are linked directly to a change on human welfare, hence, corn is an ecosystem service, its nutritional value once it is consumed constitutes a benefit (Boyd and Banzhaf 2007; Fisher and Turner 2008; TEEB 2010). However, by and large, precise understandings on how changes in nature affect human well-being and livelihoods are missing (Balmford and Bond 2005; Daw et al. 2011a,b).

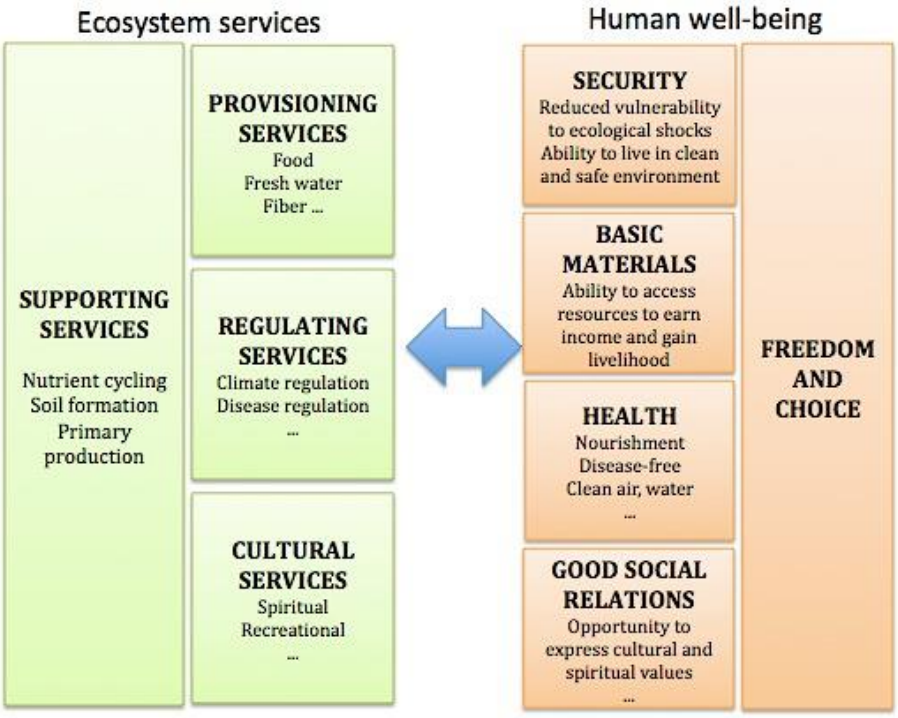


Figure 3-1. Conceptualization of ecosystem services and human well- being according to the MEA (2003) framework

As a researcher of environmental management I had been familiar with scientific assessments of ecosystem services. However, I wanted to better understand the distribution of impacts and benefits resulting from the exploitation of ecosystem services in agricultural communities. Hence, I became interested in the potential of mixed participatory methods in general, and photovoice in particular, as a way of complementing the now ubiquitous assessments of ecosystem services. The need for inclusion of community perspectives in ecosystem assessment and management has been widely recognized (Folke et al. 2005; Waltner-Toews et al. 2003). Communities offer the most direct route to understand the complex relations between ecosystems and well-being (Fabricius et al. 2007), often highlighting the entrenched power dynamics that affect environmental decision-making. Indeed, questions about who profits and who suffers are critically important given that benefits

and burdens resulting from environmental management are unequally distributed in society, across geographical regions and through time.

In this paper, I reflect on my experience of using photovoice as an approach to better understand the relationship between ecosystem services and well-being while promoting wider community engagement. The paper is divided into four sections: (1) a review of photovoice as a method of inquiry; (2) a description of the area of study, the Volcán River watershed in Southern Costa Rica; (3) a summary of how community members in an agricultural watershed relate ecosystem services to different dimensions of their well-being; and (4) a discussion of the implications of this form of analysis for participatory environmental management.

Photovoice

Photographs and other visual tools have been integrated in social science research in a variety of ways. Early anthropologists used photographs for documenting social or cultural phenomena. In 1967, John Collier coined the term "photo elicitation", which consisted of using photographs as props during interviews to stimulate and guide responses, effectively creating the field of visual anthropology (Harper 2002). Variations of photo elicitation have been adopted in psychology, education or organizational studies (Hurworth et al. 2005). The underlying idea is that images are more effective in evoking experiences and insights than spoken or written words alone (Carlsson 2001; Harper 2002). In photo elicitation, the researcher usually provides the pictures upon which the participants comment, by contrast, in photo novella and photovoice, the researched take their own photographs. Photo novella and photovoice share similar origins, however, photo novella focuses on having participants tell

their stories by photographing their everyday lives (Wang and Burris 1994), whereas photovoice is a process by which "people can identify, represent and enhance their community through a specific photographic technique" (Wang and Burris 1997, p.369). Hence, the storytelling element is relatively less central in photovoice.

Photovoice is theoretically situated within the fields of education for critical consciousness, feminist theory and documentary photography. Following Freire's approach for critical education, photovoice uses the pictures taken by the participants to create "coded situation problems", that is, abstractions that allow people to reflect upon their own realities (Wang and Burris 1994). Photovoice also emphasizes praxis - the combination of reflection and action to promote change (Freire, 1970) - by entrusting the cameras to people so that they become active agents in transforming their reality. From feminist theory, photovoice considers the power dynamics and biases that exist in participatory research and it intends to become a vehicle for disempowered and hard-to-reach groups that include women but also children, peasants, the illiterate or any stigmatized population (Wang and Burris 1994). Finally, the idea behind documentary photography is to capture in pictures socially relevant phenomena (Wang and Burris 1994). In the case of photovoice, participants determine what phenomena are important, thus providing an insider perspective into an issue. These theoretical foundations underlie the three goals of photovoice, which are: to enable communities to identify their strengths and concerns; to promote critical dialogue around key issues; and to affect policy (Wang and Burris 1997; Wang et al. 1998).

Photovoice has been applied to participatory needs assessments in the study of a range of issues such as health (e.g. Wang et al. 1998; Carlsson 2006; Short 2006), homelessness (e.g. Dixon and Hadjialexiou 2005; Rhodes et al. 2008), stigmatized groups (e.g. Graziano 2004;

Hussey 2006), disability (e.g. Jurkowski and Paul-Ward 2007; Thompson et al. 2008) or experiences of immigration (e.g. Streng et al. 2004). Yet, the application of photovoice techniques to questions of environmental management remains limited (some exceptions are Bosak 2008; Castleden et al. 2008, 2009) and it is altogether absent from the literature in ecosystem services, even though some authors have used other participatory techniques, such as participatory rural appraisal and rapid rural appraisal, in assessing ecosystem services (e.g. Pereira et al. 2005). I argue that photovoice is an underutilized methodology that has the potential to complement biophysical ecosystem service assessments in the context of impoverished and resource-dependent communities. Especially since assessing ecosystem services and acting upon that information requires integrating the knowledges of diverse stakeholders, recognizing power imbalances, and grappling with the complexity of social-ecological systems.

Pineapple Agriculture in Costa Rica

Costa Rica is a middle-income country with an economy dependent on tourism, primary commodities and a budding technology industry. Historically the distribution of population and resources has concentrated in the Central Valley. After independence in 1821, the government focused on the expansion of the agricultural frontier through measures that promoted settlement to the North and to the South of the Central Valley, from which point the economy of Costa Rica became closely linked to the fluctuations of commodity exports, particularly coffee (Samper-Kutschbach 1993). Today the supply of export goods is more diversified, however agricultural products (bananas, pineapples, and coffee) were still among the top five exports in 2008 (Promotora del Comercio Exterior Costa Rica 2009).

The Volcán River watershed is situated in the Pacific side of the Talamanca range in Southern Costa Rica (figure 3-2). Although it is small in size, approximately 230 km^2, it contains five Holdridge life zones: montane rainforest, lower montane rainforest, premontane wet forest, tropical wet forest, tropical moist forest (McConnell 2008). The Volcán River is a tributary of the Térraba River, a watershed of national importance as well as of international significance as it feeds the Térraba-Sierpe wetland, recognized by the Ramsar Convention. Finally, the headwaters of the Volcán River are within the buffer zone of La Amistad International Park, a biodiversity hotspot in Central America (McConnell 2008). The watershed averages 3,000 mm in annual precipitation that falls mostly during the rainy season (between May and November). It has steep gradients and soils that are acidic, compacted, of clayey texture and very low fertility (Calvo-Alvarado et al. 2007).

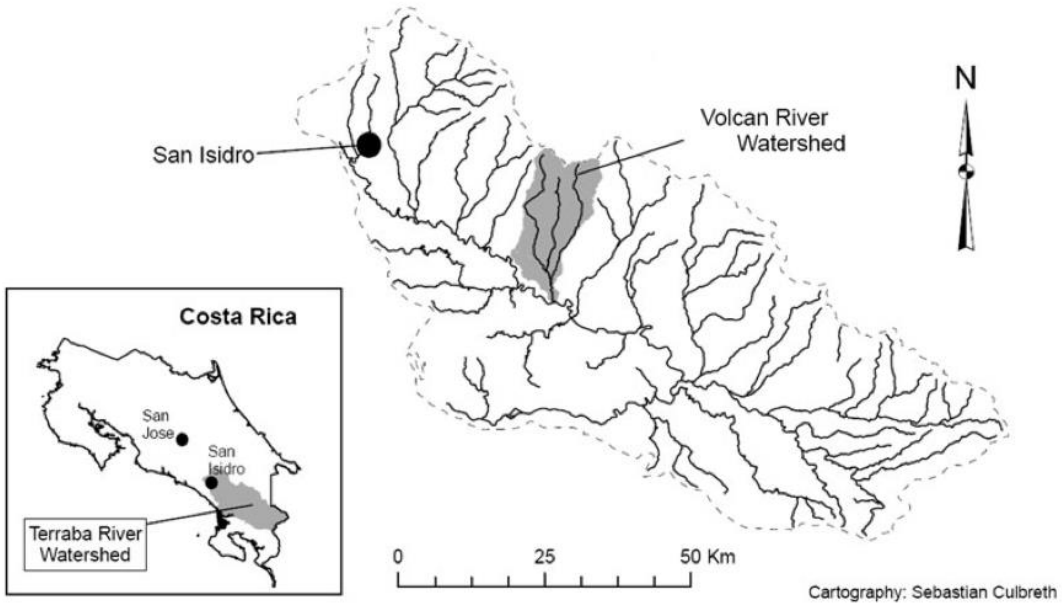


Figure 3-2. Location of the Volcán River Watershed within the Térraba River Basin (Source: Wright 2010, with permission)

The Volcán watershed has a population of 3,500 people, divided into 12 communities. Settlement in the South-Pacific region of Costa Rica occurred only in the 1900s when the

construction of transportation routes and large land concessions promoted the establishment of cattle farming (Hilje-Quirós 1993). During that time, newcomers to the Volcán watershed, a handful of families of Panamanian origin, claimed sizeable tracts of forested land that they transformed to pasture for cattle. They also cultivated sugarcane, coffee and vegetables for household consumption. The land of the watershed belonged to these few families who employed others as manual laborers. Today, 30.9% of the households in the Southern region are living under conditions of poverty or extreme poverty, compared to the 18.5% nation-wide average (INEC 2009). The South-Pacific region is home of several Indigenous groups including the Bribri, Brunka, Guaymi, Cabecar and Térraba (Solano-Salazar 2000).

In 1978 the Pineapple Development Company (PINDECO), a subsidiary of Del Monte Produce, started operations in the county of Buenos Aires, where the Volcán River watershed is located. PINDECO bought the lands in the alluvial plain between 400 meters above sea level (masl) and 700 masl, which are flat enough to permit the operation of the large machinery that is necessary to harvest pineapples. The upper reaches of the watershed, where the land is too steep for the machinery, continue to be used for pasture, sugar cane and some coffee. The establishment of pineapple monoculture in the region was promoted by an aggressive structural adjustment program whereby the government granted significant economic incentives to foreign firms willing to develop non-traditional crops for export (Bonatti et al. 2005). This was coupled with the excellent environmental conditions for the cultivation of pineapple, including steady temperatures between 23-30ºC, abundant sunlight, acidic soils, and flat terrains in the alluvial plain (MAG 1991). Pineapple production took off and by 2008 pineapples represented 14.4 % of the net agricultural product, second only to bananas (SEPSA 2009). PINDECO had a lot to do with this expansion, having developed particular fruit varieties and a technological package that allowed the company to increase the density of plantations to

60,000-70,000 plants/ha, the highest in the country (Bonatti et al. 2005). In 2005, PINDECO operated 4,500 ha of pineapple in the Buenos Aires county (Bonatti et al. 2005).

The social and ecological changes since the arrival of PINDECO are wide-ranging (Chapman 2005). The population in the Buenos Aires county has increased six-fold since the 1950s, which has strained the capacity of institutions to deliver services and build adequate infrastructure (Bonatti et al. 2005). The structure of communities has changed, there is a shrinking middle-class overshadowed by the influx of landless wageworkers looking for low-skilled labor, while local youth migrate to larger centers in search of more inspiring work prospects. Ecologically, the impacts follow changes in land use patterns resulting from the conversion of pasture to monoculture plantations. According to Bonatti et al. (2005), these impacts include: decreased biodiversity, increased landscape patchiness, reduced carbon sequestration potential, reduced flows on the Volcán River as well as other tributaries of the Térraba River, loss of soil organic matter and a panoply of effects related to the use of agrochemicals.

Methods

I set out to explore how people in the Volcán River watershed understood the concept of ecosystem services, how they defined the benefits that they obtained from their natural environment and how they conceived of the relationship between their environment and their well-being using a combination of methods. Although in this article I focus primarily on the experience of photovoice, it is important to note that field observation, transect walks, workshops and interviews helped to set the stage for the photovoice exercise. Hence, I start with a brief description of these activities.

I lived with local families in Volcán between May and September 2009. Spanish being my mother tongue, it enabled me to participate in community life by partaking in civic committees, religious, social and sports events. Through observation of everyday life and informal interviews (n > 50), I gained insights into underlying power relationships that shaped the community, which allowed me to discern possible stakeholders groups within it. For instance, it became clear that the community of Volcán could perhaps be better understood as three neighborhoods that had emerged as the result of disparate social and economic conditions and that maintained little communication between them. I used these observations to divide volunteer participants for the photovoice exercise into homogenous groups according to their age, gender, occupation, and neighborhood, so that they would feel comfortable speaking in front of one another.

Given that the concept of ecosystem services comes from a particular tradition of Western science, I organized a meeting open to everyone in the community to introduce the research project, the vocabulary of ecosystem services and the classification of services that the MA (2003) proposes. The meeting was interactive and I asked participants to voice the things that they valued doing, being or having, and then asked them to reflect on how nature provided these. The meeting also served to recruit volunteers for the photovoice exercise. In selecting volunteers, no one was turned down and no one was specifically asked to participate. This choice resulted in a sample that did not correspond to the demographic characteristics of the region, notably males and PINDECO workers were underrepresented (table 3-1). This is partly due to the long workday in the plantations and partly due to the fear of reprisals by the company.

Table 3-1.
Characteristics of the 34 Residents that Participated in the Transect Walks

Gender		
Females	21	62%
Males	13	38%
Age		
17 and under	12	35%
18 to 25	7	21%
26 to 35	4	12%
36 to 55	9	26%
Over 55	2	6%
Neighbourhood		
Altamira	5	15%
Volcán – Centre	7	21%
Volcán – Peregrino	8	24%
Volcán – Progreso	14	41%
Occupation		
Agriculture	1	3%
Chauffer	2	6%
Housewife	7	21%
PINDECO	2	6%
Student	13	38%
Unemployed	5	15%
Volunteer	3	9%
Waterboard	1	3%

* Altamira is a small community higher up in the watershed. Volcán is divided into three neighbourhoods: the Centre is the richest, and it contains the houses of the first white settlers in the watershed; Peregrino was built to house PINDECO employees and other workers (e.g. the town's nurse, bus drivers); Progreso is the poorest neighbourhood built by people who used to live by the river but whom the government forced to move.

The actual photovoice exercise combined photovoice with a modified transect walk. Each group of 2-4 volunteer participants, e.g. young females from a given neighborhood, met with the researcher separately (see table 3-2). The participants agreed among themselves on a route within the geographical limits of the watershed, which usually took between 3 to 4 hours to walk. In choosing the route, there were no specific instructions given or requests made to participants, other than the routes should allow for the exploration of ecosystem services that affected the participants' well-being positively or negatively. While the region is rural – communities are made up of neighborhoods of 20-30 households surrounded by pineapple fields – participants often chose routes some distance away from their neighborhoods and that contained natural features, such as a creek. All participants were shown how to use a digital

camera and two cameras were provided for them to take pictures during the transect walk. They were asked to take pictures of ecosystem services that affected their health and well-being, in positive or negative ways. Prior to the start, the meaning of the term 'ecosystem service' was revisited and a handout with examples was given to them for reference. Depending on the group, less technical terms, such as 'environment' or 'nature', were used interchangeably with ecosystem services. During the walk, participants were encouraged to adopt the role of guides in interpreting for the researcher how the ecosystem and the changes in the landscape affected their well-being and to take as many pictures as they wished. In total, I conducted 11 transect walks in which 34 people participated.

Table 3-2.
Transect Walk Groups

Characteristics of transect walk groups	**Number of participants**
Men PINDECO workers	2
Members of local water board	2
Men Altamira	2
Men Volcán El Peregrino	3
Volunteeers – Volcán El Peregrino	3
Women Altamira	3
Women Volcán Centro	2
Women Volcán El Progreso	2
Younger women Volcán Centro	4
Youth Volcán El Progreso	12

Note: The group of 12 youths did three shorter transects with four participants in each on the same day. They participated in a subsequent discussion of the photographs as one group.

At a later time, each group met separately with the researcher to discuss the photographs taken during the transect walk. Wang et al. (1998) recommend to facilitate this discussion following the line of questioning suggested by the mnemonic SHOWED, which stands for "What do you See here? What is really Happening here? How does this relate to Our lives? Why does this concern or strength Exist? What can we Do about this?" (p. 80). I preferred using a semi-structured format modeled after McIntyre (2003) that emphasizes asking what the photographs mean to participants. In this way, I used open-ended questions to ask

participants to reflect on what the ecosystem service represented in each image meant for their well-being. I also found that asking participants to choose among the 60-70 photographs that they usually took during the transect walk evoked more personal responses. Hence, after participants had discussed all of the pictures I asked them to prioritize the photographs that depicted the ecosystem services that were more important to their well-being (figure 3-3 displays a sample of the photographs taken by participants). If the group had 2 people they could choose up to 5 photographs, if the group had 3-4 people they could choose up to 10. This often brought insights into how the participants conceived of the relationships between the different ecosystem services and also hints of what participants considered acceptable, or unacceptable, trade-offs between ecosystem services. These conversations were recorded and transcribed with their permission. After completing this part, there were 65 pictures of ecosystem services in total that represented 76 benefits, or impacts, according to participants. Since there was repetition among the pictures selected by the different groups, I pooled them into 21 common themes as shown in table 3-3.

Figure 3-3. Examples of photographs of ecosystem services taken by participants during transect walks. Clockwise starting top left: Cattle was seen as a provisioning service; coffee plantations (if shade-grown grown) were seen as a supporting ecosystem service; soil erosion was seen as evidence of the decline of regulating ecosystem services; the Volcán River was seen as an example of a cultural ecosystem service.

Table 3-3.
Detailed Explanation of the Themes Captured by Transect Walk Participants

Theme	**Detailed explanation**
Creeks, waterways	Creeks are used for recreation (swimming) and they also provide some fish and water for irrigation during the dry season. Some creeks are contaminated by untreated grey waters and animals (cattle).
Infrastructure	Roads and bridges are essential for communication, safety and livelihoods. Residents often worry about their poor condition. However, the water filtering system in Volcán is among the region's best.
Volcán River	The Volcán River was seen in positive ways. It fulfilled a variety of functions including providing freshwater, serving as a gathering place and as a spot for recreation.
Coffee	Coffee is a supplemental source of income in which the whole family participates and it is consumed locally. Coffee can be part of mixed cultivation system (agro-forestry) which benefits the environment.
Erosion	Soil erosion and deforestation were worries for residents who associated them with increased flooding, less predictable environment, and a reduction on the forest capacity to provide freshwater.
Mountains	The Talamanca mountains have a variety of positive connotations. They give a sense of place, they provide water and regulate climate.

Pineapples	Pineapples were seen as a source of income which was positive. However, residents also worried about the effect of pesticides on air quality and on the workers themselves.
Sugar cane	Sugarcane was seen as a source of income, and hence as something positive. However, there were concerns about air quality (due to burning) and loss of habitat.
Garbage:	Garbage worries residents who see it as a health hazard and as a symptom of the lack of civic values or environmental consciousness. Some also pointed out the practice of burning garbage as negative.
Flood	Flooding is a worry for residents who regularly have to cope with environmental uncertainty and risk as well as with significant material losses.
Forest/trees	Forested areas and some trees are cherished by residents who enjoy going for walks and view them as part of a healthy environment.
Fruit tree	Fruit trees were appreciated because they supplement food sources and some of them had cultural connotations as they are ingredients in traditional meals.
Puddles/standing water	There are concerns about the presence of puddles near the houses where dengue mosquitos breed. Rotting pineapples in the fields attract flies that are a nuisance for cattle and humans.
Sewage	Piping for grey waters goes above-ground, which concerns some residents. This is especially true in the poorer neighbourhoods were the water does not actually flow properly and forms puddles.
Cattle	Cattle was associated seen as providing income in the region (it was the dominant economic activity until 1970s) but there are concerns about the presence of cattle by the river.
Fauna	Butterflies characteristic of the region are positively regarded as increasing the enjoyment that residents get from nature.
Flora	Participants commented on how they appreciated some flowers and they pointed out that flowers fulfill ecosystem functions, such as pollination, but they didn't relate pollination with their well-being.
Medicinal	Medicinal plants found in the wild are used by many residents to treat a variety of ailments.
Outdoor recreational	Green spaces (such as the town's square or playgrounds) are used for sports and as gathering spaces.
Pesticides	Pesticide use is widespread in large plantations and to kill weeds (on the side of the road). Residents were suspicious about their effects on their health.
Reforestation	Reforestation activities along the river are viewed as beneficial as they can reduce erosion and in this way reduce the damage done by flooding.

I interpreted the results from the small group discussions according to the MEA (2003) framework to classify ecosystem services and their effect on human well-being (table 3-4). For instance, a group of participants said about a picture depicting a cart loaded with cut sugarcane: *"This is sugarcane. We think it is good because it brings money. But it also brings chemicals and who knows what, which are bad […] We also make a lot of desserts from sugarcane like sobaos and agua dulce".* Hence, I classified sugarcane as a provisioning service (after MEA 2003 and TEEB 2010), and based on their explanation I gathered that participants associated sugarcane negatively with the deleterious health effects of agrochemicals, and positively with increasing their material welfare and giving them a sense of identify that comes from making

traditional Costa Rican foods. Although I originally intended to uncover possible correlations between particular stakeholder groups in the watershed and the ecosystem services that affected their well-being, the small sample size prevented me from running statistical tests.

Table 3-4.
Links Between Ecosystem Services and Aspects of Human Well-Being Identified by Community Members. The First Column on the Left Summarizes the Themes Identified by Participants During Their Transect Walks Together with the Frequency that the Theme was Mentioned. In the Next Column, the Ecosystem Function is Classified Using the Categories of the MEA (2003). The Number of Stars (*) that Appear Indicate how Often Participants Identified a Particular Theme With a Particular Kind of Ecosystem Function. The Next Section Indicates the Impacts that the Ecosystem Function had on the Participant's Well-Being. If the Participant Spoke Positively of the Ecosystem Service it is Indicated With A " + ", If s/he Spoke About it Negatively it is Indicated With A " – ".

Number of pictures depicting an ecosystem service		Ecosystem function type					Impact on human well-being identified by participants			
		Provision	Cultural	Regulating	Supporting	N/A	Material for good life	Health	Social relations	Security
Creeks, waterways	8	***	**	***			++	++--	+	+
Infrastructure	6					na	+		-	++--
Volcan River	6	*	*****				+	+	++++	
Coffee	5	***			**		+++	++		
Erosion	5			*****			-			----
Mountains	5		***	*	*		+	++	+	+
Pineapples	5	**		***			++	---		
Sugarcane	5	**	*	*	*		+++	--		
Garbage	4		***	*				---	-	
Flood	3			***						---
Forest/trees	3		***					+	+	
Fruit tree	3	**	*				++		+	
Puddles/standing water	3			***				---		
Sewage	3			***				---		
Cattle	2	**					+	-		
Fauna	2		**					++		
Flora	2		*	*				+		
Medicinal	2	**						++		
Outdoor recreational	2		**					+	+	
Pesticides	1			*				-		
Reforestation	1			*						+

Results

Out of the list of ecosystem services identified, there are eight aspects that were mentioned more often and that can be considered priorities, these are: The state of waterways and creeks; the Volcán River; human-made infrastructures such as roads and bridges; pineapple plantations; sugarcane; coffee; erosion and the mountainous landscape. The emphasis on water, crops and mountains is not surprising since these characteristics dominate the physical landscape of the watershed. In terms of ecosystem services, participants identified a variety of functions from their environment but provisioning, cultural and regulating services were more prominent than supporting services. Table 3-5 below summarizes the links between ecosystem functions and human well-being.

Table 3-5.
Number of Times That Participants Identified Particular Types of Ecosystem Services With Aspects of Their Well-Being. Categories Are Based on the MEA (2003) Framework.

	Material for good life	Health and healthy environment	Social relations	Security
Provisioning	14	3	-	1
Cultural	-	9	9	-
Regulating	1	15	-	8
Supporting	1	3	-	-
Infrastructure	1	-	2	4

Provisioning Services

The provisioning services of importance related mostly to food sources from which people derive their livelihoods (cattle, coffee, pineapple, sugarcane), but also to the availability of fresh water and some medicinal plants. When participants talked about a photograph that depicted a provisioning service, they associated it with material aspects of well-being (77 percent of the time), and to a lesser extent with having access to a healthy environment (17

percent of the time) and security (6 percent of the time). It was interesting to note how participants spoke of fruit trees compared to monocultures: while the first group was referred to as "natural" or "given by nature" and their relation to well-being was portrayed as sustenance, the latter was not perceived strictly as food but rather as a source of income. Indeed, pineapples and sugarcane are not primarily destined for local consumption. This hints at how the introduction of monoculture agriculture brought the beginning of the disassociation of labor and sustenance, something relatively new to this region (Bonatti et al. 2005). Further to this point, one participant observed: "before the father would bring home the fruit of his labors, corn or beans… Nowadays he goes to work 12 hours and only the money comes back". Overall, participants seemed caught in between mourning for the loss of values connected to working the land and welcoming cash-earning opportunities, however younger participants agreed that "if one is to improve, s/he has to leave the town".

Pineapples, sugarcane and coffee were among the provisioning services more frequently mentioned and there were differences in how participants viewed the impacts of these crops on their well-being. Pineapples and sugarcane were often depicted as a necessary evil, that is, participants agreed that these crops provided them with an income that was needed, but they also pointed out negative health effects for themselves and for the environment, e.g. the use of agrochemicals or air pollution from burning the sugarcane before harvesting it. Coffee on the other hand was seen in a much more positive light. For instance, participants indicated that coffee plants can be combined with trees and that this "protects the land [against erosion], produces oxygen that we humans need and captures carbon dioxide". As well, participants emphasized that coffee picking can be a family activity, usually employing women and teenage children during harvest. This contrasts with pineapple agriculture that has

a much more gendered workforce, where fieldworkers are invariably males and women are hired in the pineapple packing factories (along with some males).

Regulating Services

Residents associated regulating functions with aspects of their well-being that related to their health and the health of the physical environment (63 percent of the time), as well as with security (33 percent), in the sense of being safe from natural disasters and having predictable surroundings, and the provision of materials for a good life (4 percent). Nearly three quarters of all the regulating services were perceived as worries, these included erosion due to land-use change; contamination of waterways due to inadequate sewage treatment; side-effects related to monoculture cultivation (e.g. air pollution from pesticide use or from burning sugarcane during harvest); and flooding.

In terms of security, the periodic flooding of the river is worrisome to residents in the centre of Volcán, which sits on the river's floodplain. In an informal interview with an elder woman she mentioned how she worries during the rainy season when she hears the river rushing loudly behind her house. Despite revelations of this kind, and despite having had an unusually high flood in 2007 that broke bridges and caused substantial material damage, many Volcán residents oppose the county government's efforts for risk zoning and relocation. This is because residents feel that they have not been properly compensated during past relocations.

Along the same lines, residents were concerned about erosion. The watershed has naturally very steep terrain, as the river descends from an altitude of 3,000 meters above sea level at the headwaters to 450 meters above sea level in the alluvial plain, in less than 30 km of horizontal distance. However land use change has played a critical role in altering the physical characteristics of the soils in the region (Krishnaswamy and Ritcher 2002). Indeed, the

photographs that participants took to illustrate erosion depicted agricultural landscapes. They also photographed the banks of the river, which under Costa Rican Forestry Law (article 33) must have a vegetated buffer of at least 15 m if the terrain is flat and at least 50 m if the terrain is steep, to show that non-compliance is widespread. Participants expressed their frustration at landowners for not doing their part for conservation and indeed, some of the more active grassroots efforts in the watershed are directed at reforesting the riversides.

In terms of human and environmental health, the main worries of participants revolved around pollution, inadequate waste treatment and disease. Participants associated contamination with the spray of agrochemicals on the pineapple plantations, which are separated from human dwellings only by a natural barrier of tall grasses that is missing in places. A mother commented that sometimes when she "leaves [her] kid in the kindergarten [she] can smell the pesticide", someone else mentioned that "those who spread the poison in the fields have a hard time having babies" or that "the pesticides affect their head". To date, an epidemiological study on the health effects of pesticides used on pineapple plantations in Costa Rica is still needed. However, residents have reason to worry based on past experience from other monocultures (e.g. banana plantations are notorious) and the poor track record in occupational safety of many of the transnational companies that operate in the country (see for instance Thrupp 1991; Sass 2000; Wesseling et al. 1993, 2001).

Participants identified a variety of environmental conditions that could have an adverse effect on their health. This was often in relation to some form of contamination, where the regulating capacity of the ecosystem to absorb pollutants had been exceeded. For instance, participants mentioned the risk of getting a skin condition "from fungus in contaminated creeks" that receive untreated grey waters from the houses. Other times, in drawing the

connection between health and the environment participants alluded to deficiencies on the built infrastructure. An example was the presence of "mosquitoes with white spots that live in puddles" that transmit hemorrhagic dengue. In this case, the puddles that residents photographed formed on the unpaved streets in their neighborhoods, which they consider problematic by themselves.

Cultural Services

When participants identified cultural functions of ecosystems these revolved around recreational uses, especially around waterways that helped to build social relations; the aesthetic beauty of the mountainous landscape and local flora and fauna species. On the other hand, participants were critical about the presence of garbage in their environment as they associated it with the lack of education or civic values. In terms of livelihood impacts, cultural services were identified to affect participants' health (50 percent of the time) and their social relations (50 percent of the time).

Almost every transect group chose to include the Volcán River during their walk, which speaks to its centrality. One of the main cultural benefits that the river has served historically is as a gathering place for families. A participant recalls "going to the river on Sundays and finding all the neighbors cooking and sharing food". From the transect walks and other interviews, the consensus that emerges is that residents appreciate what the river provides even though they indicate that its integrity is declining. For instance, participants talked about physical changes of the river that have altered their experience of the place, e.g. "there used to be shade where you could cool down", or "it used to have a lot more water". In some cases, participants showed me old pictures of the river that demonstrated the physical transformation.

Participants identified and boasted about their natural surroundings, and there was a range of benefits that participants derived from their natural settings. Some pointed to how they enjoyed seeing particular fauna, e.g. butterflies. Others observed how "tourists come to see here what they don't have over there". Indeed, eco-tourism is often mentioned as an alternative livelihood option in the watershed, although there is little in terms of concrete action. Still others highlighted the value of landscape features. One group of women showed me a small lake that they do not visit very often, but that "just knowing that it was there" made them happy.

Supporting Services

Participants identified few supporting ecosystem services. In fact, participants did not photograph supporting ecosystem services as such, rather they brought up supporting functions - like soil formation or nutrient cycling - while talking about the pictures of other ecosystem services. This is to be expected because ecosystem services occur as bundles of interacting variables across space and time (Rodriguez et al. 2006; Brauman et al. 2007; Raudsepp-Hearne et al. 2010b). For example, while discussing the photograph of a shade-grown coffee plantation, a participant mentioned that it was "almost like a forest because you can plant poró trees which protect the soil and give us oxygen and sequesters carbon dioxide" and went on to contrasting it with sugarcane, which is grown as monoculture plantations and does not provide any of these benefits. When participants mentioned supporting services they linked these with securing their basic materials for a good life (25 percent) and maintaining a healthy environment (75 percent).

Photovoice in the Assessment of Ecosystem Services

As mentioned earlier, the goals of photovoice are threefold: 1) to enable communities to identify their strengths and concerns; 2) to promote critical dialogue around key issues; and 3) to affect policy (Wang and Burris 1997; Wang et al. 1998). With respect to these specific goals, the use of photovoice in the Volcán River watershed was effective in the following ways: first, in terms of identifying strengths and concerns, photovoice encouraged residents to make visible what matters most to them (Turner et al. 2008). In doing so, it is the people in the community, and not the researcher who determine what is relevant to the study, choosing the elements and the relations in the system to which they wish to bring attention (Waltner-Toews et al. 2003; Hurworth et al. 2005). Depending on the context, photovoice can be a tool for openly exploring all issues that a community faces, or it can be more focused on a particular aspect. Since I was interested in the relationship between ecosystem services and well-being in order to inform a future plan for participatory environmental management in the watershed, I used ecosystem services as the entry point while being open to include broader concerns about the environment. Hurworth et al. (2005) observe that photovoice tends to produce unpredictable information and, in reviewing the assessment, it was surprising to note the number of pictures of human-made infrastructure that were important for residents but that would have not been included in a typical assessment of ecosystem services.

Photovoice also provided an arena for people to highlight positive aspects of their ecosystem. In fact, when participants discussed possible routes for the transect walks, it was evident that showing me something that they liked was a consideration, even though I just asked them to show me ecosystem services that affected their well-being in positive or negative ways. In turn, this uncovered places that would have gone unnoticed, or whose

meaning could have been misconstrued. For example, a group of youth took me to a water hole, most certainly contaminated, but that serves as a fun hangout for them. Likewise, coffee was characterized in mostly positive terms, even though coffee plantations are by no means free of agrochemicals. Hence, in this manner photovoice was a way to correct the researcher's assumptions while facilitating the creation of community perspectives.

Second, with respect to critical dialogue, photovoice helps to create informal conversation forums (Wang and Burris 1997). Since pictures and cameras are rare in the community, it is likely that participants would talk with non-participants about their experience, thus fostering informal dialogue around watershed issues. At the same time, it was interesting that because pictures are fairly self-explanatory and there was a sense of anonymity during the exercise, participants felt freer to photograph issues that were difficult to address openly otherwise. For example, the number of pictures of pineapple plantations from the photovoice exercise contrasted with the experience during an unrelated workshop where people were asked to identify drivers of change in their community and pineapple agriculture was not mentioned once. Indeed, the relationship between PINDECO and the communities has experienced ups and downs. Tensions ran high in the 1990s, when a grassroots movement formed in Volcán to bring attention to the company's environmental impact and PINDECO responded with harsh pressure tactics eventually leading to the demise of the movement (Chapman 2004).

Third, with respect to affecting policy, it is still too early to tell. While a few town leaders were involved in the photovoice exercise, there is a need to include decision-makers at other levels of governance, which will be the objective of follow-up activities. However, this initial assessment can be utilized as a rough baseline to monitor and document change in an

inexpensive, yet convincing manner. Particularly for those manifestations of the ecosystem that are visible to the naked eye, e.g. the amount of vegetative cover by waterways, the physical appearance of streams, the presence of garbage, the absence of grass fences surrounding the plantations, the existence of areas with poor drainage around the houses, and so on.

In terms of the larger picture, this assessment aspires to be an initial step in influencing current ecosystem management practices in the watershed towards broader participation from community stakeholders. Currently, the agribusiness model that has been operating in the region for the past 30 years bypasses local community actors in the decision-making process, thus leaving them powerless and vulnerable to environmental change. By contrast, photovoice is compatible with the goals of community-based participatory research, which aim to reduce power differences, build trust and create a sense of ownership (Castleden et al. 2008). Although far from achieving the desired goals in this short time, processes such as photovoice that create critical dialogue around issues important to residents have the potential to catalyze community self-organization, a critical component for empowerment.

Challenges

While photovoice has tremendous potential as a participatory tool in the assessment of ecosystem services, there are also important limitations. For one, taking pictures of ecosystem services is a difficult thing. The main drawback is that, at times, important aspects of ecological integrity are hard to capture in film given the scale at which they occur (e.g. landscape patchiness, soil nutrient loss) and so the photographic equipment available will limit to some extent the scope of the issues that are discussed. Similarly, photographs produce snapshots but cannot capture dynamic flows as one could do with a video-recorder. Hence the dynamic

relationships of ecological functions cannot be depicted effectively using photos only. Some have observed that it is important to consider not just what is photographed but also what is left out of the pictures (Bosak 2008). This issue is common to participant-driven methodologies and it can be explored by asking participants specifically what factors influenced their choice of subjects (Bosak 2008). Finally, the rich, complex data that photovoice produces can be hard to convey in a straightforward manner to policy-makers and it is therefore best to complement it with evidence of a different kind. In many photovoice studies some form of triangulation is used, e.g. field observation or reflexive journals. In the case of an assessment of ecosystem services, it would be important to include these as well as a biophysical assessment to get a more complete picture.

Likewise, there are limitations with the use of the MA (2003) framework in this context. While the MA offers a good start for thinking about the relationship between ecosystem services and well-being, it would be best to let participants define their own categories for these terms and the scales at which they are relevant. In turn, this would allow classifying the photographs into ecosystem services collaboratively. Instead, I felt that the technical language of the MA would have precluded some participants (although not all) from engaging with it.

One important insight that comes from attempting to interpret what participants felt about the pictures in relation to the MA (2003) framework is that it would be best to distinguish between ecosystem services and ecosystem benefits as suggested earlier (Boyd and Banzhaf 2007; Fisher and Turner 2008; TEEB 2010; Daw et al. 2011a,b). Along these lines, I propose to consider the path from the biophysical reality to the realization of human benefit as mediated by social processes as shown in figure 3.4. First, through ecosystem management humans manipulate ecosystem functions to produce a flow of ecosystem services, which can be

roughly subdivided into provisioning, regulating, supporting and cultural services. Food crops are considered provisioning ecosystem services (MA 2003, 2005; TEEB 2010). Ecosystem services become benefits once they increase human welfare. Environmental governance structures influence the access and distribution of ecosystem services into ecosystem benefits. As an example, warm temperatures, abundant sunlight and acidic soils are physical characteristics of Southern Costa Rica. An environmental management regime that relies heavily on mechanization, chemical inputs and irrigation has been established in this region to produce pineapples (an ecosystem service) in monoculture plantations. Through a series of global trade agreements the pineapples are sent outside of the country where they become a benefit for North American and European consumers, or it provides a material benefit to workers in the form of a salary. The process that I have outlined is artificially neat, however, two important insights that emerge from this characterization is that there can be a gap between where ecosystem services are produced and where the ecosystem benefits are realized and that this is mediated by environmental management and governance structures.

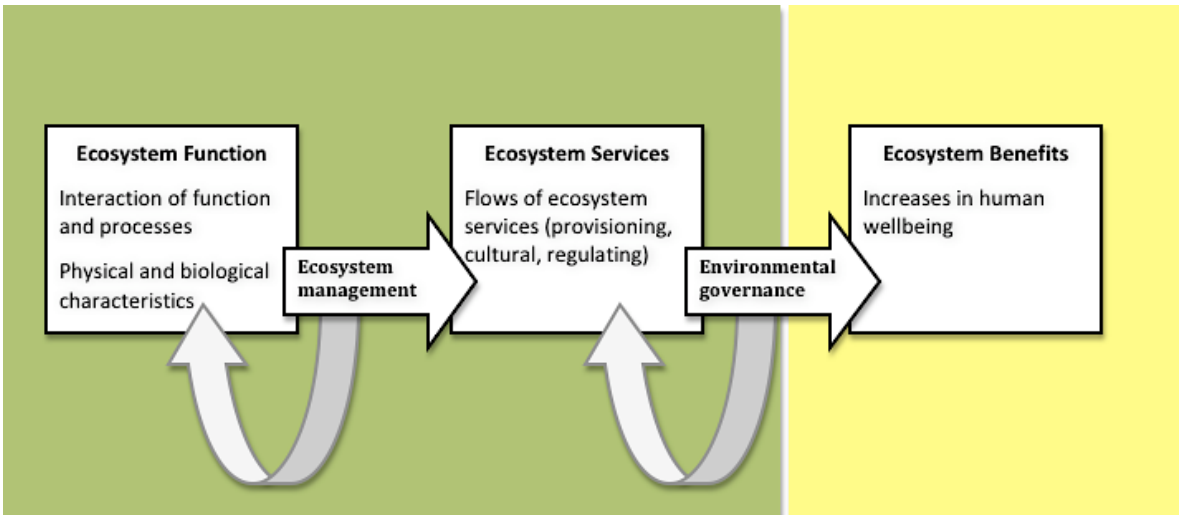


Figure3-4. Pathway from ecosystem function to ecosystem benefit (based on TEEB 2010)

Conclusion

Understandings of ecosystem services from a community perspective provide valuable insights into the relationship between ecosystem services and human well-being. In the case of the Volcán River watershed, the assessment revealed that participants associated provisioning ecosystem functions predominantly with material aspects of well-being; regulating services with their health and safety; cultural services with developing social cohesion, a sense of place and creating civic values; and supporting services with having a healthy ecosystem. Photovoice can provide a conduit for residents to define the strengths and concerns of their community, thus correcting the perspective of outsiders while fostering wider discussion. Although it has potential to affect policy, it is difficult to assess the impact in the case of Volcán River watershed.

The idea advanced by the MA (2003) that human well-being depends on ecosystem services has served well as a departing point and for illustrative purposes, however, its simplicity is deceiving. It would be more illuminating to consider ecosystem services as distinct from ecosystem benefits. This difference is important in the type of analysis that I conducted because while most people generally agreed on what were the main ecosystem services, there might have been more divergent opinions were different stakeholders to consider the benefits that they each derived from the same ecosystem function. This is because the production of ecosystem services does not result, in a straightforward manner, in the increase of human well-being. Instead questions of access (Ribot and Peluso 2003), distribution and personal circumstance mediate the transformation of ecosystem services into ecosystem benefits (Daw et al. 2011a,b). Understanding these differences will be an important consideration for future work that should delve deeper into the underlying power relations between stakeholders that

regulate access to ecosystem benefits. Likewise, a more targeted approach to choosing participants might have been more revealing of the different perspectives.

CHAPTER

4. GATEKEEPERS OF ECOSYSTEM SERVICES: UNDERSTANDING ACCESS TO ECOSYSTEM SERVICES IN THE BRIBRI INDIGENOUS TERRITORY

"If you want to understand the deepest malfunctions of systems, pay attention to the rules and to those who have power over them"

Dana Meadows

To the extent that ecosystem services provide a platform to explore the linkages between ecosystems and human well-being, they are increasingly seen as a useful tool to understand and improve livelihoods in resource-dependent communities. While in some conceptualizations ecosystem services are considered the benefits that humans derive from ecosystems (cf. Costanza et al., 1998; MEA, 2003; Harrington et al., 2010), the complexity of human welfare and the heterogeneity of even small communities, suggest that there is a need to better contextualize the relationship between ecosystems and well-being. This can be accomplished by considering how changes in the level of provision of ecosystem services differentially impact actor groups, how the personal circumstances of actors themselves affect their ability to benefit from an ecosystem service, or the role that access and power dynamics play in determining the distribution of benefits (Daw et al., 2011). This article focuses on the latter. Considering these details is especially pertinent in the context of poverty alleviation, as it highlights how increasing the production of ecosystem services cannot effectively reduce poverty unless it is also accompanied by governance mechanisms that ensure that rural

communities benefit from the exploitation of their ecosystems. Furthermore, it needs to be understood that the ability to produce ecosystem services mobilizes the interests of diverse stakeholders who try to position themselves to enjoy access to these benefits and often to control the access that others may experience. In this process, power relations between the different social actors are negotiated, established and challenged.

This article examines how access and power relations affect the benefits experienced by Indigenous plantain producers in the Bribri Territory (Costa Rica). Through the analysis of key informant interviews, field observation and secondary literature, the article describes how traditional and conventional plantain producers experience different degrees of access to the factors associated with the production of provisioning ecosystem services in their region. Furthermore, the analysis of access makes it possible to identify key gatekeepers, that is, actors who control the access enjoyed by others, and to articulate the form of power that gatekeepers use to establish and maintain their position. The article suggests that traditional plantain farmers experience a higher degree of control whereas, in switching to conventional agriculture, Bribri farmers relinquish power to middlemen who are outsiders to the community. Thus, the advancement of intensive agriculture can be seen as having both ecological and social repercussions.

The analysis of access and power proceeds in three steps: First, I identify how access to the processes and variables related to the production of ecosystem services is gained, controlled and maintained within the social-ecological system of plantain agriculture in the Bribri Indigenous Territory. Second, I use this information to identify gatekeepers in this system, that is, I examine which actors emerge as powerful key figures because they are positioned in a way that they are able to regulate the access of others. Third, I identify the

mechanisms by which these gatekeepers are able to exercise their power. Finally, I identify possible leverage points that could be used to change or challenge existing power relations and improve human well-being in resource-dependent communities.

Site Description

This research focuses on communities in the Bribri Indigenous Territory situated in the Talamanca county in South-Atlantic Costa Rica. Talamanca is one of the largest counties in the country and it is extremely diverse as it extends from sea level to 3,500 meters above sea level (masl) in less than 40 km of horizontal distance. Hence, it makes sense to distinguish between Lower Talamanca, which encompasses the areas below 500 masl, including the coast, the Sixaola River valley and the start of the Talamanca mountain range; and Upper Talamanca, which comprises the areas above 500 masl. The differences in climate and terrain between Lower and Upper Talamanca translate into different land uses. This research focuses exclusively in the part of the Bribri Indigenous Territory situated on Lower Talamanca, where there is a mix of traditional and more intensive forms of agriculture. Among the variety of crops that are produced in Talamanca, only bananas, plantains, and cacao have found stable markets and can be considered a source of income for families. However, the relative importance of these three cash crops for farmers changes over time due to economic and environmental factors, such as price fluctuations or the emergence of plant disease. Talamanca produces 52% of the plantain, 90% of the organic banana, and 6% of the commercial banana production in Costa Rica (Municipality of Talamanca, 2003).

The Bribri Indigenous Territory was recognized as such in 1977 as a result of the passing of Costa Rican Indigenous Law. The territory spans 437 km^2 and has a population of

8,500 residents who live predominantly in the communities of Suretka and Shiroles. The Bribri Indigenous Territory is governed by a local Indigenous government known as the Integrated Indigenous Bribri Development Association of Talamanca, or the Asociación del Desarrollo Integral Indígena Bribri de Talamanca (ADITIBRI, Spanish acronym), which is composed of local representatives elected through a voting among Bribri residents. The three communities that are part of this research are Shiroles, Suretka, and Amubrë (see figure 4-1). Suretka and Shiroles are contiguous to each other and they are situated on the road connecting the Bribri Territory with the coast, whereas Amubrë is on the opposite side of the Telire River (a tributary of the Sixaola River). Hence, there is no direct road access to Amubrë from outside of the territory; instead, the Telire River needs to be crossed by boat. While the three communities are within a 4-mile radius of each other as the crow flies, the additional remoteness that crossing the river implies is significant because Amubrë is less exposed to non-Indigenous influences. Consequently, residents in Amubrë tend to maintain a more traditional lifestyle that is reflected in their agriculture practices, compared to those in the communities of Suretka and Shiroles where conventional agriculture has had a higher degree of penetration.

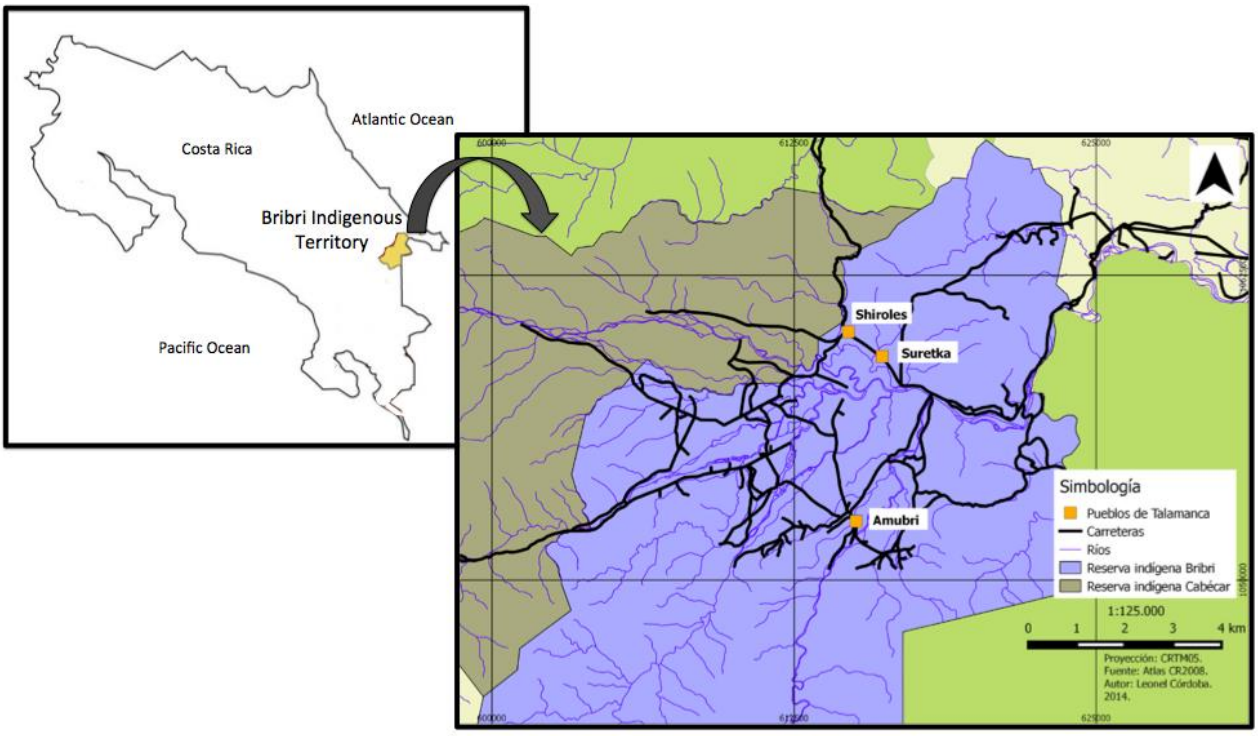


Figure 4-1. Situation of the Bribri Indigenous Territory in Costa Rica and the three communities that form part of this study (Amubrë, Shiroles and Suretka). Source: L. Cordoba (with permission).

Terms used to describe agricultural practices carry different meanings depending on the context. This article subscribes to the definitions of the FAO (2009) where the term "conventional agriculture" refers to agriculture characterized by monocultures, mechanization and the use of agrochemicals; and the term "traditional agriculture" refers to indigenous forms of farming, usually as diversified agricultural systems, that rely on local knowledge and natural (non-synthetic) inputs. Two examples of what these agricultural systems look like in the Bribri Indigenous Territory are shown in figure 4-2.

Figure 4-2. Two agricultural systems found in the Bribri Indigenous Territory. Left: traditional farm with interspersed crops (cacao on the foreground, plantain and other fruit trees on the background). Right: A conventional plantain farm. Source: Author.

Methods and Theoretical Frameworks

The analysis is based on key informant interviews conducted with elders, cooperative leaders and members of the local Indigenous government (n=8), semi-structured interviews with female and male Bribri agricultural producers (n=42), as well as field observations and secondary literature. The key informant interviews were conducted by the author, whereas the semi-structured interviews were conducted by the author and a field assistant. All interviews were conducted between June and November 2011.

The semi-structured interviews were transcribed and coded. Coding was an iterative process that involved a first reading of each interview transcript, an initial round of coding by hand to identify large themes, and a second round of coding to identify nuances and draw connections between the themes. The qualitative data analysis software Atlas.ti was used for the latter. The key informant interviews were not transcribed; instead notes were taken to

capture factual details. Finally, field observations occurred during several field visits where the first author stayed in the community of Shiroles.

The data analysis used a combination of inductive and deductive reasoning. On the one hand, the search for themes was guided by theoretical frameworks about access and power that are detailed below. At the same time, given the paucity of attempts to examine power within the ecosystem service literature, it was important to be open to themes and contradictions emerging from the data.

Theorizing Access

Ribot (1998) and Ribot & Peluso (2003) offer a framework for analysing access in the context of natural resources and global commodity chains that is useful for the analysis of provisioning ecosystem services. The proposed framework intends to explore who benefits from natural resource extraction and through what channels. Ribot & Peluso (2003) define "access" as all the possible mechanisms by which a person is able to benefit from things. In the context of agriculture, the 'things' from which a person might benefit concern the outputs of the exploitation of the agricultural ecosystem, or agricultural ecosystem services. While the range of ecosystem services derived from agriculture is vast – ranging from crop production to pollination – I am focusing on the provisioning ecosystem services that are commercialized and that determine to a large degree the livelihood of the communities in the study. By 'mechanisms', the framework considers all the means, processes and relations that are at the individual's disposal to exercise access at a given time, and they can vary from a signed legal agreement to bribing. Ribot & Peluso (2003) suggest thinking of access as constituted by a bundle of strands that are woven together to create a particular web of benefits experienced by an individual or a group at a given time. Some of the strands that are instrumental in the

production of ecosystem services include access to: land, tools and technology, capital and credit, markets, knowledge and information, and labour opportunities. These are the strands that I use to guide the analysis of the Bribri agricultural social-ecological system. Ribot & Peluso (2003) suggest a three-step analytical process: First, identify the flow of benefits of interest, which in this case relates to the benefits associated with the production and commercialization of plantains. Second, identify mechanisms by which actors gain, maintain or control the flow of benefits where, maintaining access refers to the efforts dedicated to keeping a particular benefit; to gain access, refers to the process of establishing access; and to have control refers to the ability of regulating others' access. The third step is to analyze the power relations underpinning these mechanisms of access wherever a benefit is realized.

Theorizing Power

Conceptualizations of power and related concepts, such as agency or influence, are diverse. In this section, I present five ways of understanding power: overt, covert, latent, structural, insidious and decentralized (see figure 4-3). This is not intended as a comprehensive categorization or a historical review; rather it aims to highlight some of the ways of thinking about power that can be relevant to the analysis of social-ecological systems.

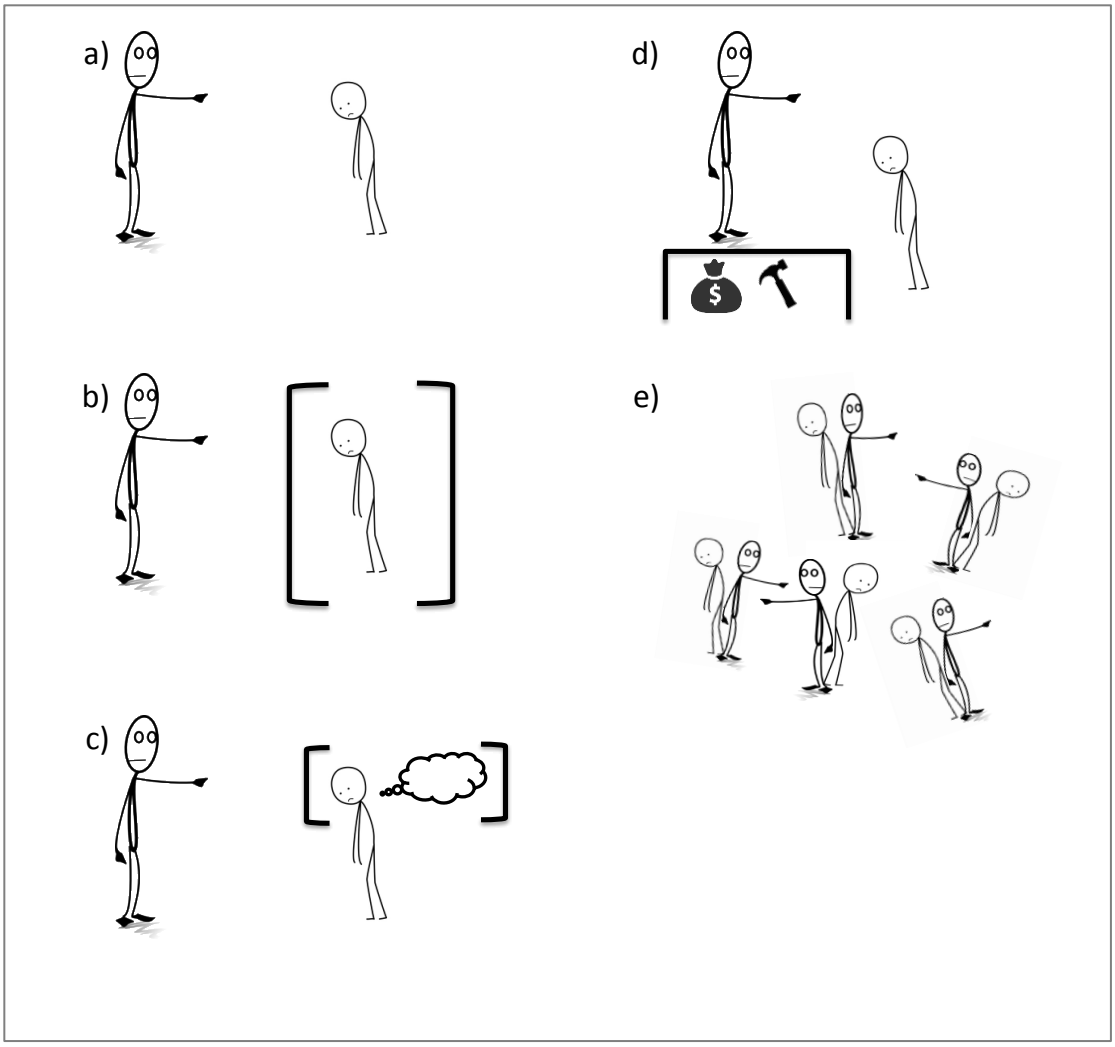


Figure 4-3. Different ways of thinking about power: a) overt power; b) covert power or agenda setting; c) latent power as controlling discourses and narratives; d) structural power; and e) decentralized power

Overt power. Sometimes the exercise of power is evident from observing the behaviour of a group of actors deciding over a contentious issue. This is referred to as the pluralist view of power after Polsby (1960) and Dahl (2005), or the one-dimensional view of power (Lukes, 1974). Dahl (2005) proposes that a person has power over another to the extent that the first can get the latter to act in a manner that they would not do otherwise. In this conceptualization power is understood as influence, or "power over", and the exercise of influence can range from persuasion to coercion to force.

Covert power. Because 'overt power' emphasizes empirical observation of conflict, it removes the importance of everything that does not constitute a decision event (Bachrach and Baratz, 1962). That is, the pluralist model does not account for non-participants or for non-decisions. It also does not account for the extent to which powerful actors are able to set the agenda and prevent debates that run contrary to their interests from surfacing. As Schattschneider famously argued, "all forms of political organization have a bias in favour of the exploitation of some kinds of conflict and the suppression of others because organization is the mobilization of bias. Some issues are organized into politics while others are organized out" (1960, p. 71). This form of power that is based on setting the agenda and defining the limits of what is debateable is known as the two-dimensional view of power (Lukes, 1974).

Latent power. Following the two previous conceptualizations, it is difficult to ascertain the power dynamics between groups of actors when there is no overt disagreement. Yet Gaventa (1980) points out that quiescence needs not be equivalent to consent, on the contrary, power is often involved in the suppression of conflict and dissent. Likewise Lukes (1974) claims that the ultimate expression of power is when people "accept their role in the existing order of things, either because they can see or imagine no alternative to it, or because they see it as natural and unchangeable, [...]" (p. 24). This has been called the three-dimensional view of power and it refers to the manner in which powerful actors are able mobilize social myths, narratives and symbols to further their own interest.

Structural power. Structural analyses focus on why a given individual or group has power, rather than on who has power. Therefore, structuralists tend to examine the systemic conditions that produce and underpin power differentials and, to a large extent, the structuralist concept of power is concerned with class relations that are mediated by the

organization of production within a society (Isaac, 1987). Indeed, a large part of structural analysis is concerned with the understanding of conditions that lead to the exploitation of labour. In agricultural societies these relations might be associated with factors such as ownership of the means of production, the social division of labour, and the distribution of income and other benefits (Bernstein, 2010).

Decentralized power. The previous models for thinking about power assume that power emanates unidirectionally from those who have the ability to impose their will onto others. But power can also be more circular and relational, that is, power can be understood as a network of relationships and discourses that take place within a social group, rather than imposed from above (Foucault, 1980). From this perspective, everyone is embedded in power relations in such a way that everyone can be both potential recipients and potential sources of power. A decentralized understanding of power highlights that power relations are not only vertical but they can also be horizontal.

Analysis of Access in the Bribri Territory Social-Ecological System

Land Access

Access to land in the Indigenous Bribri territory is regulated by Costa Rican Indigenous Law, which states that "Indigenous reserves are inalienable, imprescriptible, non transferable and exclusive for the indigenous communities living on them". All of the land of the territory is registered under the name of the Indigenous local governing body, ADITIBRI, which subsequently grants Indigenous residents the right to use particular plots of land. Families usually have access to several parcels in separate locations to which they often assign different land uses. Typically, plots situated in the fertile floodplain are used for agriculture, and plots in

the hillier parts are maintained as forest for conservation purposes. Decisions about land-use are taken at the household level; hence, while in principle the land in the territory is communally owned, for practical purposes land can be thought of as an almost private resource to which a household controls access. Initial access to the land is gained either through inheritance or through purchase between Indigenous residents. Among those interviewed in this study, 32% had less than 2 ha, 59% had between 2 and 10 ha, and 9% had more than 10 ha of land. These figures represent total land holdings. On average, one hectare of land in the territory can support the following yields of commercial crops: 5,000 bunches of plantain per hectare per year, or 265 kg of cocoa per hectare per year, or 6,350 kg of banana per hectare per year (Orozco et al., 2008).

In terms of maintaining access to land, residents are protected by Costa Rican Indigenous Law, which stipulates that Indigenous people can negotiate and transfer land only among themselves and clearly states that non-Indigenous people cannot acquire or lease land in the territory. Yet, approximately 35 percent of the land in the Bribri territory is currently in non-Indigenous hands and this loss of control over land has been identified as an issue by the local government, particularly around the more accessible communities of Shiroles and Suretka (Guevara-Viquez, 2011). Non-indigenous land ownership is primarily due to in-country migration, migration from Nicaragua during the 1980s, as well as intermarriages (Whelan, 2005). Although the local government has conducted campaigns to return the land to Indigenous residents, progress on this front requires considerable resources and legal disputes can take a long time until a settlement is reached. The cases of intermarriage are especially complicated because Indigenous status is defined differently in the Costa Rican legal framework and in the Bribri tradition, which is a matrilineal society and therefore considers that inheritance, land and group membership are passed on through the daughters.

Along with losing land to non-Indigenous residents, an additional challenge to maintaining access to land is the rapid population growth experienced in Talamanca. The population of the canton has more than quintupled in the past 40 years, rising from 2,790 inhabitants in 1973 to 30,712 inhabitants in 2011 (INEC, 2012), most of it concentrated around the communities of Suretka and Shiroles (Yepéz 1999). This means that the size of the plots has diminished to the point that several of the families interviewed reported having insufficient land for subsistence agriculture or for commercial crops. The problem affects more acutely the young and those living in the lower part of the territory, whereas the elderly and those who live in the more remote upper areas have maintained sizeable landholdings (Whelan, 2005). At the same time, there has been a process of intensification, where land use in the area surrounding Shiroles has changed from being fallow and forested land to becoming permanent crops such as plantain monoculture, agroforestry, and agroforestry with banana for commercial purposes (Whelan, 2005). The following comment from a male producer reflects this transition (T030):

> *"Here we make a living from selling plantain or banana… But we don't have large plots of plantain, nor banana […] Someone who has a lot may have one or two hectares… or a half. So we can't make ends meet, we just can't […] Maybe if we put aside some savings, but the money that we make biweekly is very little. All of that has been changing because when I was a kid my parents grew rice, and beans… Now it's only those living in the mountains who do that. Us living here, we don't do that anymore"*

Tools and Technology Access

The tools and technology required to produce plantains depend on the form of agriculture that the farmer uses, traditional or conventional. Generally speaking, the upkeep of plantains requires cleaning the debris of the base of the plants, de-leafing, removing suckers

and rotted stems, and weeding (Robinson & Galan-Sauco, 2010), as well as fighting off pests such as banana weevil (*cosmopolites sordidus*), black Sigatoka (*mycosphaerella fijiensis*), Panama disease (*fusarium oxysporum*) and nematodes. In the traditional system, the upkeep of plants is done using manual labour and with the help of simple tools, such as machetes. Pests are controlled by managing shade to prevent their proliferation, which involves pruning and interspersing tree species of varying heights (Polidoro et al., 2008). Some farmers also use pseudostem traps, which are traps constructed by making a cut on a tree stump so that it preferentially attracts the banana weevil borer (see figure 4-4). As well, some farmers use vegetable-based insecticides made out of the sap of the sandbox tree (Polidoro et al., 2008). All of these activities involve simple, affordable tools that most farmers are able to purchase and know how to use. Hence, it is relatively easy for traditional farmers to gain, control and maintain access to the tools and technologies needed to practice traditional agriculture.

Figure 4-4. Pseudostem trap to combat banana weevil. Source: Rural Universe Network, 2009

By contrast, conventional plantain plots involve additional tools and technologies, the majority of which are geared to fighting the pests that are more problematic in monocrop agriculture. The most commonly adopted pest-fighting measure is the use of chlorpyrifos-coated plastic bags used by 98% of conventional farmers to protect the fruit against thrips

(Polidoro et al., 2008). While the chlorpyrifos-coated bags serve to reduce thrips, their use also responds to a cosmetic demand imposed by middlemen because the bags make the peel of the fruit look greener and smoother (Barraza et al., 2011). Other agrochemicals used in monocrop plantain plots include nematicides, herbicides and fungicides. The cost of an agrochemical often determines the extent to which it is used. For instance, fungicides used to combat black Sigatoka (*mycosphaerella fijiensis*), are expensive hence, they might be applied only occasionally or not at all (Polidoro et al., 2008). Although figures vary widely, in a study conducted in 2007 farmers reported spending on average 380 $US/ha on fertilizers and 368 $US/ha in pesticides per year, which together represented 40 percent of their farming expenses (Polidoro, 2007).

The cost of purchasing additional inputs means that initial access to the tools and the technology necessary for monocrop agriculture depends on the availability of cash, effectively acting as an entry barrier for many Indigenous farmers who are often limited in this respect. However, since middlemen pay a higher price for plantains produced conventionally, there is a strong incentive for farmers to switch. In relation to agrochemicals, a female producer from Suretka commented:

> *"It's a market demand. At least here, they ask you to use the [chlorpyrifos-coated] bags because the fruit looks nicer, it doesn't have a single spot […].There is an economic aspect too. They pay the plantain with the bag better than the plantain without the bag. The plantains without bag may be 1,000 colones per bunch, whereas the plantains with the bag are 2,800 or 3,000 per bunch. Although the price is going down… But still, if they pay you 800 for the bunch, the one with the bag is 1,800. It always has a better price"* (T002).

In addition, middlemen are only too happy to finance the switch of farmers upfront in exchange for the harvest later on (more on this below). However, once farmers switch to the conventional system, they relinquish control over access to the tools and technologies necessary for production to the group of middlemen who impose their own commercial demands. Furthermore, the middlemen extend their control over the tools of production because they often become the distributors of the agrochemicals, given that there are no stores in the communities selling agricultural products.

Knowledge and Information

Access to agricultural knowledge and information depends, once again, on the form of agriculture practiced by the farmer and it is related to the tools and technology employed. In traditional agriculture producers make use of knowledge that is codified within a larger set of cultural rituals and practices that regulate which plant and animal species can be harvested and how much (Garcia-Serrano & Del Monte, 2004). There are different degrees of control in terms of what and who regulates access to this information: some of this information is common enough that a person living in the territory might be exposed to it throughout their upbringing or encounter it in their everyday activities; more sophisticated information might be the purview of certain individuals, such as elders (*awapas*) and traditional healers (*sikuas*), or of specific clans within the society that act as the keepers of particular knowledge and information.

To gain and maintain access to this information Bribris rely on their group and clan membership status, which involves partaking in cultural rituals and fulfilling prescribed roles. However, since colonization, external pressures have undermined Bribri cultural beliefs to the point that it may be difficult to access these within a few generations. For example, starting in

the 1950s the Costa Rican state sought to increase its influence in the territory through the imposition of the Costa Rican educational system (which initially forbade children from speaking their Indigenous language), the introduction of Costa Rican institutions of law and order in the territory, and by allowing the establishment of proselytising non-Indigenous religious groups (Rojas-Conejo, 2002). Of particular importance with regards to agriculture was the arrival of the United Fruit Company, founded by North American entrepreneur Minor C. Keith, at the turn of the 20th century. Floods and plant disease drove the company away from the Bribri Indigenous Territory in the 1930s but, all the same, the plantation system left a legacy that marked the beginning of a period of economic integration (Rojas-Conejo, 2002). In particular, the United Fruit Company introduced wage labour and the basic road infrastructure necessary to transport produce out of the territory. The push towards further economic integrations continues today and the change in lifestyle is evident across generational lines, that is, the older generation tends to value traditional agriculture, even self-sufficiency, whereas the younger generation welcomes wage labour. An older resident explained: *"Today's youth, what they have - the little that they have - they sell it. They sell their lands and they don't want to work. So we need to buy things from outside because they don't want to cultivate the land"* (T024). Hence, while it is relatively easy to gain and maintain access to the knowledge necessary to carry out traditional agriculture, continued external pressures pose a threat to its long-term viability and they might eventually render this knowledge inaccessible to future generations because of the changing lifestyle.

On the other hand, plantain monocrop agriculture requires a set of knowledge and information different from the traditional practices because of its emphasis on agrochemical pest-control. Previous studies have pointed to gaps in Indigenous farmers' knowledge regarding the identification of pests, proper agrochemical dosage, health impacts of pesticides

and the use of personal protective equipment (Polidoro et al., 2008, Barraza et al., 2011). Indigenous farmers indicated that they felt some inadequacy about their knowledge of conventional agriculture practices, as a farmer explains:

> *"A lot of our people, people in our community who work with conventional, that is, with chemicals, they lack that knowledge. So they apply too much fertilizer to the plants and then the soil gets really hard. And they add too much poison and that too damages the plants"* (T030).

In some cases Indigenous farmers have knowledge about agrochemicals because of previous experience in large commercial plantations outside of the territory however, by and large, the picture that emerges is that middlemen control access to information about conventional agricultural practices. It is important to note that the advice dispensed by middlemen is not based on best-management farming practices. Instead, middlemen impose commercial requirements for the sale of the product, such as the use of chlorpyrifos-coated bags, and then tell farmers how they should meet them. Hence, it is not surprising that Indigenous people over-apply agrochemicals (Polidoro et al., 2008) or have a distorted sense of their use.

Markets

Plantains from the Talamanca region are sold to both national and international markets. This paper focuses on Bribri farmers who sell their fruit through two channels: One channel is via a middleman who in turn brings the plantains to a central depot in the capital city of San Jose where large- and medium-size food retailers purchase the fruit. The other channel is via farmer cooperatives that sell their produce internationally. Farmers who sell to middlemen tend to practice conventional agriculture because middlemen pay a higher price for

conventional plantain. Middlemen have access to a truck and they come from outside of the territory to buy plantains directly from Bribri farmers who bring their harvest to a sales point in the community of Suretka accessible by water and road (see figure 4-5). Because of their remoteness, Bribri producers wanting to sell in the national market have little choice but to sell through the middlemen; thus, middlemen control access to the market by controlling the transportation route. This arrangement has further implications because it creates a market that is closer to an oligopsony (few buyers relative to the number of sellers), which gives middlemen an undue advantage to determine the price. For instance, farmers claim that middlemen collude to fix the price of plantain. Furthermore, over time middlemen have introduced requirements of an exploitative nature, e.g. farmers mentioned *el castigo* (literally "the punishment"*),* which means that a plantain bunch containing less than 35 plantains has to be sold at half the price (as a two-for-one or even as a three-for-one). A producer from Suretka mentions,

> *"they say that if the bunch doesn't have 30 fingers, it doesn't count. If it has 28 fingers, they say it's a 2 for 1. But if you have one with 40 fingers, they don't say that that one has more… they treat it as just another bunch"* (T011).

Yet, bypassing the middlemen to gain access to the national market is next to impossible for Indigenous producers because middlemen and retailers in the central depot maintain a tight system of reciprocal loyalties. Indeed, Indigenous farmers reported that even when some of them organized to bring produce to the depot, the retailers refused to purchase from them directly. What maintains loyalty in this system is a combination of long-standing relations, the possibility of monitoring each other (e.g. a retailer would know if a middleman sold the

plantain to someone else and *vice versa*) and possibly some degree of prejudice against Indigenous peoples. A producer from Amubrë explains,

> "*But when they [Indigenous producers] go to San Jose, they lose because the market belongs to the middlemen. The retailers don't buy the product because they have their middlemen who have been coming for years. If you go there with your produce, they tell you that that plantain is not good, that that plantain is this or that… What are we going to do? We have to give it away in San Jose".* (T027)

Figure 4-5. Plantain and banana sales point on a sandbank of the Telire River in Suretka. Source: Author.

In an attempt to gain and control access to markets, and to better prices, Indigenous farmers began organizing into cooperatives in the 1990s. Cooperatives are set up by producers who practice traditional agriculture and include all three cash crops – bananas, plantains and cocoa – destined to international markets for retailers of organic and fair-trade products. In

this way, Indigenous farmer cooperatives are able to bypass the central depot in San Jose where they would get a lower price for organic plantain or might not be able to sell at all. Access to the international market depends on the viability of the cooperatives themselves. Whereas some cooperatives have been successful over the years, many have dissolved in part due to the pressure exercised by middlemen who increase their purchase price temporarily to attract farmers away from the cooperative as they begin to form. A farmer (T019) from Suretka-Shiroles explains this process:

> *"[…] So then, the middleman puts the price at 2,500 colones. I want to sell at 2,500, so I go to him and I only sell to you [the cooperative] a little. Now you at the cooperative don't get the same production that you were expecting, because he increased the price by 500 colones. So then the cooperative goes up to 2,500, but he increases it to 3,000 to hurt those people. Because the middlemen know what's going on. They decide to increase the price so that people quit the cooperative. That's what always happens."*

Capital and Credit

The changing lifestyle towards fuller integration into the market economy has increased the need for money in the territory. This need is relatively recent as even a generation ago most residents led a lifestyle based on self-sufficiency. Today, the production of cash crops reduces the land that is available to plant diet staples such as rice and beans, which means that these and other staples have to be purchased. As well, conventional farmers need to buy additional agricultural inputs. Indeed, to some degree, the need for cash is responsible for the expansion of plantain and banana agriculture that replaces the more traditional cocoa, since *musas* can be harvested on a biweekly or monthly basis ensuring a regular income (Orozco et al., 2008).

Residents of the Indigenous Bribri Territory have no access to formal loans from financial institutions because they are unable to provide a land title as collateral. This is a consequence of the status of the region as an Indigenous reserve where there is a single land title in the name of the local government. Hence, only communal projects and initiatives backed by the local government can secure access to credit. Given the situation, Bribri farmers often turn to middlemen to gain access to informal credit. Middlemen gladly finance the switch to conventional agriculture upfront in exchange for their crop (Whelan, 2005). This also ensures that the farmer stays with the particular middleman who provides the loan. As a farmer explains (T027):

> *"When he [the middleman] brings me all those things and I spray them in my lot, then he says "OK, the produce is mine, you can't sell it to another trucker because I'm the one helping you". I sell it to him, I get the cash, perhaps more than I used to get, and he continues to suggest more things, but he's also tying me up because when it's payback time, he's going to get paid back alright! Because perhaps the price is 5,000 but he's going to pay me 1,000 and keep the 4,000, and what can I do? […] and still we continue to work happily with them"*

The amount of informal lending and the interest rates are difficult to assess but Dahlquist et al. (2007) determined that 26% of the households in their study received credit from plantain middlemen and this percentage increased to 53% for households in the more accessible parts of the territory such as Suretka and Shiroles. Aside from the credit that farmers obtain from middlemen, producers did not mention other informal credit systems such as peer-to-peer lending or micro-credit. The exceptions were gifts and in-kind exchanges that were mentioned as part of traditional practices that were becoming less common.

Labour

Plantain farms are family-run operations where over 90% of the producers rely on the work of their household members to tend to the production, while the remaining 10% of producers hire day-workers, especially for tasks that are physically demanding or considered unpleasant, such as spraying pesticides (Orozco et al., 2008). Hence, theoretically, the majority of farmers can easily gain and control access to labour. However, because day-workers tend to be young and landless, their continued availability is threatened by the desire of the young to adopt a more modern lifestyle away from agriculture. Indeed, producers pointed the disinterest that youth demonstrate in pursuing the farming lifestyle and how instead youth prefer to get paid work outside of the territory, especially in the ballooning ecotourism industry. Even if youth is interested in agriculture, producers indicated that state institutions, such as the National Child Welfare Board (PANI, Spanish acronym), interfere with their ability to involve their own children in agricultural activities. A farmer explained:

> *"before we used to grow up with our parents. They took us to work to share with them where they went to saw cacao, banana, whatever… We think that that's normal. But now that the PANI has arrived, God forbid that you take a kid out for a walk, they are going to say that you are abusing him!"* (T020).

While the last sentence is meant as a joke, the quote alludes to the extent to which farmers feel doubtful that they can rely on household members for farm labour.

Conversely, from the perspective of those who are searching for work opportunities, the main impediment to accessing them is the general lack of cash in the region. In fact, the lack of access to paid work opportunities, farming or otherwise, was a recurrent concern in the territory. In the recent past, and to a lesser degree today, producers organized reciprocal help

in kind through practices such as the *mano vuelta* (literally 'returned hand'), where two people would agree to do work to help one another, and *chichadas,* where a large job was done collectively and everyone was invited at the end to share *chicha* (an alcoholic drink made out of fermented corn). However, these transactions involved no money and they were generally less structured than a formal job, e.g. a person might come to help one day, but the next day goes elsewhere to help another person. Interviewees mentioned that these practices are becoming less common.

Understanding Power Dynamics

There are important differences between the configuration of access and corresponding gatekeepers associated with the traditional and conventional agricultural systems (see table 4-1). Exploring the configurations of the two systems is key to understand how farmers are able to benefit from the production of ecosystem services in their communities. In the traditional system gatekeepers tend to be predominantly the producers themselves, whereas in the conventional system, middlemen play a more central role.

Table 4-1.
List of Factors Affecting the Production of Ecosystem Services and Corresponding Gatekeepers

	Traditional System	**Conventional System**
Land	ADITIBRI grants access to land in both systems	
Tools and technology	Individual farmers are able to gain, control and maintain access to the relatively simple tools required for traditional agriculture	Middlemen finance the cost of switching upfront, thus granting initial access. Middlemen maintain access by becoming a distributor of the inputs that farmers need regularly
Knowledge and information	Individual farmers (through group membership) are able to gain, control and maintain access to knowledge codified in cultural practices	Middlemen divulge information and knowledge to meet sale requirements
Markets and pricing	Middlemen control access to the national plantain market Organic cooperatives control access to international plantain markets and organic certification	Middlemen control access to the national plantain market

Capital and credit	Individual farmers do not have access to formal credit	Middlemen provide informal credit for farmers
Labour	Individual farmers rely on household members for farm labour (and hired labour to a lesser extent)	

The configurations of access that forms under the conventional and the traditional systems are different in at least two ways: First, the number of gatekeepers. In the conventional system middlemen become gatekeepers regulating access to most aspects of plantain production. The two exceptions are access to land, which is defined by Costa Rican law and locally managed by the Indigenous government ADITIBRI, and decisions about hiring labour that are relegated to the household sphere. By contrast, in the traditional system there is a wider group of institutions and actors that behave as gatekeepers controlling the different aspects of ecosystem service production. What this means is that power becomes concentrated in fewer hands as the conventional system of agriculture becomes the dominant form practiced in a community.

Second, the position of the gatekeepers with respect to the communities and the Bribri people is different in the two systems. More of the gatekeepers in the traditional system come from the local context and therefore share a common history and cultural background, whereas in the conventional system gatekeepers are outsiders to the community and predominantly non-Indigenous. Hence, the spread of the conventional system of agriculture has the associated effect of extending outside influences into the territory. Given the extent to which identity is tied to agricultural practices in resource-dependent communities, the switch from traditional to conventional agriculture involves more than simply a change in land management practices, it is linked to the reshaping of Indigenous identity. This is potentially problematic not because it involves change –as Indigenous identity is constantly evolving –but because the new identity reflects the priorities of outsiders who lack historical and cultural references. In other words,

this particular switch in land management practices is potentially tied to the erosion of Indigenous identity.

Seeing Like a System

The configurations of access described above produce, and are produced by, distinct power dynamics. Previously I characterized five mechanisms that can be used to establish and maintain power over others: overt, covert, latent, structural and decentralized. To some degree, all five forms of power are present. However, in this case, the reinforcing dynamics between structural, overt and latent power are key to understand the distribution of benefits derived from plantain agriculture in the Bribri Indigenous Territory. First, it should be noted that while the communities in the territory are rural and residents identify as farmers, plantain producers profit only indirectly from this ecosystem service (sensu Daw et al., 2011; Reyers et al., submitted). Farmers might use a small portion of plantains for household consumption, but the bulk of the benefit that farmers derive from plantains comes from their sale. Hence, the conditions in which the economic transaction between farmers and middlemen takes place have a great impact on the well-being of farmers.

The analysis suggests that middlemen are able to maintain an oligopsony in the Bribri Indigenous Territory as the following feedback loop solidifies (see figure 4-6): Middlemen initially come into the picture having a structural advantage over Indigenous farmers, namely, middlemen are able to bring the fruit to the central depot because they possess a truck (or have access to credit). Because there are few middlemen compared to the number of plantain producers, middlemen have a strong incentive to agree on the sale price instead of competing among them, which would lead to higher purchase prices. The oligopsony and the remoteness

of the territory mean that farmers have little choice but to accept the price established by middlemen. This is a clear display of the overt power that middlemen exercise over the plantain producers. A farmer complains (T042):

> *"We can't go and decide the price of food at the grocery store, so why can they [the middlemen] name the price of our product? They tell us "Look, the price went down in San Jose"… But if there are five middlemen, they all get together and say we're going to pay this much, let's tell them that the price is low in San Jose, the Indians (sic) won't know… So it's what I said before, they mistreat farmers"*

An initial display of overt power has the potential to morph into latent power over time. Put simply, when a group loses repeatedly over overt power struggles, it is likely to question its self-worth. As farmers feel increasingly cornered into accepting the price established by middlemen, it is likely that they start to doubt that a different outcome is possible, and they might even start to accept the present situation as natural. For instance, it is telling that the relations that farmers and middlemen maintain are devoid of antagonism, at least on the surface. When farmers are asked about how the sale price is established, a typical answer is (T006):

> *"In terms of prices, I understand that there are places people have a say on the price. Here we are used to… we are used to what the middleman says, not to what our work is worth, but to what the middleman says. If the middleman comes and says, "okay, the price of plantain is 1,000 colones", what are we going to do? We accept it".*

The finality that these words convey shows the extent to which the opinion of middlemen is accepted without challenges. Furthermore, it is significant that, while farmers

often described pricing as an unfair process in the interviews, they had a harder time formulating alternatives to obtain a fair price, such as creating a cooperative or boycotting. Instead, farmers mentioned the inability of Indigenous people to organize, citing corruption or selfishness, or their lack of knowledge to explain the current situation (T030):

> *"I hope that someone would come, because us here… If I reach out to my fellow Indigenous brothers and tell them that I want to look for a market for plantain, they won't believe me. The first thing that they'll think is that I'm acting up, that I want to steal the show. They won't support me. But if a white person comes […] they will believe him. Whites are capable, whites won't steal from us. They are capable because they come from outside, they know where to go to find the market. They will believe him, but if one is born Indigenous and he says "I'm going to look for a market", they won't believe him. The first thing they'd say is that he's trying to steal from us".*

Much less frequently did farmers identify that, far from an innate inability to organize, their efforts are purposefully undermined. For instance, middlemen temporarily increase prices to draw away members from emerging cooperatives; as well, middlemen have built a reciprocal system of alliances with the buyers in the central depot that acts as an entry barrier for new sellers. As well, one cannot forget that this process occurs within a larger context where history, colonial legacies and some present-day discourses work together to undermine Indigenous identity. Negative stereotypes and an institutional context that favours the invisibility, or erasure, of Indigenous peoples have taken a toll. To be sure, some farmers pointed out to the external forces that weaken Indigenous organization, but it was far more common to hear self-deprecating comments. Finally, to close the feedback loop, as farmers

rationalize their position in the plantain trade, the middlemen continue to reap the benefits from the sale of plantain, which only puts middlemen at a further structural advantage.

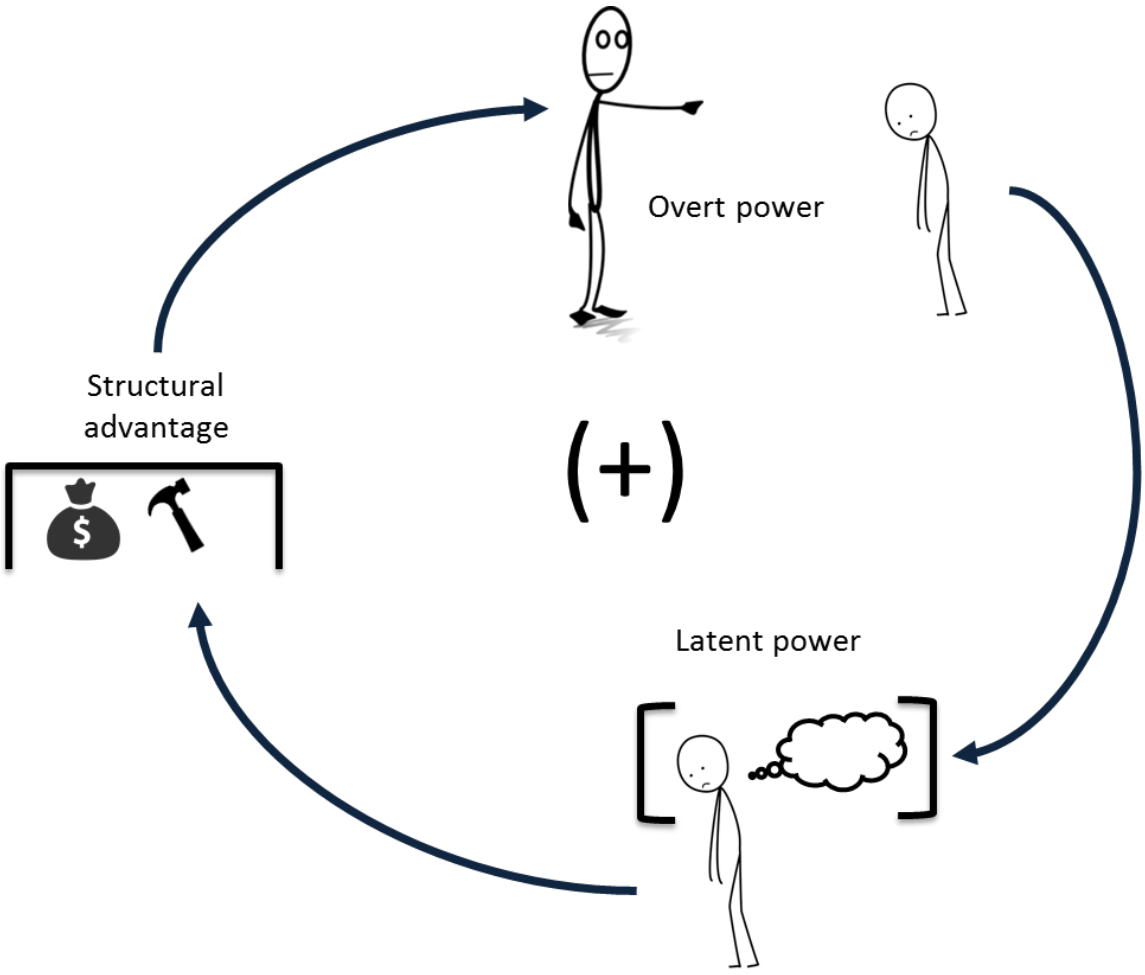


Figure 4-6. Reinforcing feedback loop occurring between different forms of power

What is to be done?

There is nothing static or prescriptive about the current configuration of access in the Bribri Indigenous Territory. To the contrary, as with any dynamic system, the relations that outline access can change under the right circumstances by undoing some feedbacks and setting up new ones. In particular, anything that disrupts the feedback loop described above

can upset the present distribution of power and corresponding benefits. Some leverage points within the system are: First, to disrupt the overt power than underlines the oligopsony established by middlemen, alternative markets for plantain need to be created. An obvious place to start is through the sponsoring of farmer cooperatives. Cooperatives appear with some regularity but they tend to be short-lived as middlemen pressure members to leave the cooperatives by temporarily offering better sale prices. An exception has been the Association of Small Producers of Talamanca (APPTA, Spanish acronym) that was founded in 1987 and currently has over 1,000 members. One of the reasons for the success of APPTA is that it has found an international market for at least some of its products, such as the organic fair-trade cocoa. Thus, if Indigenous farmers could be linked with the international plantain market, they will be able to bypass both the middlemen and the buyers at the central depot. Second, access to formal credit is key to challenge the difference in the respective material basis of middlemen and Indigenous farmers that concedes the former a structural advantage. This entails amendments to Costa Rican Indigenous Law, so it is unlikely to be resolved quickly. However, in the short-term, micro-credit or peer-to-peer lending schemes are options that merit further exploration. Third, proposing solutions to challenge latent power is difficult because of its pervasive nature. However, anything that challenges the role of middlemen as gatekeepers can open up alternatives. For instance, middlemen provide most of the information that farmers receive about pesticide application and the price of plantain. Any channel, from word-of-mouth to apps, that could serve as an additional source of information to farmers could help to question the authority of middlemen. Last, the more farming is constructed as a purely lucrative activity, the more it makes sense for farmers to switch to conventional agriculture since it offers better economic incentives. Yet, among traditional farmers, some mentioned that the reason why they continued with the traditional system was tied to their identity as

Indigenous peoples and their role as ecosystem stewards. This suggests that a closer identification of sustainable farming practices with Indigenous knowledge and identity could help slow down the switch to a system that drains power and decision-making away from the community.

Conclusion

To conclude, this article has analyzed how access to different dimensions of ecosystem service production is negotiated in the Bribri Indigenous Territory. The analysis of access and power in plantain farming in the Bribri Indigenous Territory provides an example to understand how the organization of production around ecosystem services plays a key role in determining the benefits that producers derive from ecosystem services. In this case, there are two agricultural systems that produce different configurations of access but that share common bottlenecks. Importantly, the main bottleneck is the lack of access to an open market, which gives undue influence to the middlemen who transport the plantain from the territory to the central depot in the capital. These middlemen emerge as gatekeepers who are able to regulate the key benefits derived from the production of ecosystem services.

The analysis of access and power is effective in understanding local level dynamics that shape the landscape of incentives and disincentives to which producers respond. As well, the analysis identifies winners and losers resulting from particular arrangements of resource exploitation, the power mechanisms underpinning them and leverage points that might lead to action. Last, the case of plantain farmers in the Bribri Indigenous Territory might be similar to the case of other primary producers in remote areas whose livelihoods depend on the sale of a reduced number of provisioning ecosystem services. Although exploratory, this work responds

to calls to consider explicitly the role that access plays in the distribution of ecosystem services (Daw et al., 2011). The analysis above offers an interpretation of how the theory of access developed by Ribot & Peluso (2003) could be applied to the framework of ecosystem services to understand the benefits experienced by resource-dependent communities. It is a good complement to quantitative assessments of access such as the one conducted by Hicks & Cinner (2014) with fishermen in fishing communities across Tanzania, Kenya, Madagascar and Seychelles using the same theory of access. In addition, the qualitative work offers a window to explore power dynamics that may be harder to capture otherwise. While access and power are highly intractable topics, the analysis simplifies to a degree what are key elements to consider in characterizing a situation in resource exploitation. For instance, the five categories of power help to guide attention to power dynamics that may or may not be present. In this sense, the article provides the start of a heuristic that can be applicable to the study of other ecosystem services, especially those that are mediated by an economic transaction, e.g. most provisioning services, regulating services such as carbon sequestration, and cultural services such as recreation and ecotourism.

Chapter

5. Poverty and Ecosystem Services: Teasing Out The Links In Agricultural Communities

It is widely acknowledged that efforts to alleviate poverty need to consider the dynamic interaction between humans and ecosystems, particularly within the context of rural poverty (DeClerck et al. 2006, Suich et al. 2015). The framework of ecosystem services is one of the platforms for exploring poverty prevention and reduction as it focuses on the interface between ecosystems and human well-being. Among the most-cited definitions of ecosystem services is the one proposed by the Millennium Ecosystem Assessment (MEA) that considers ecosystem services as the benefits that humans derive from their natural surroundings (MEA, 2003). The MEA classifies ecosystem services as provisioning, regulating, cultural and supporting services and it links them to human well-being, which is conceived as a multidimensional concept that includes material welfare, health, safety, meaningful social relations, and freedom of choice and action (see figure 5-1). While the MEA's (2003, 2005) definition has found ample resonance, there is still a need to better qualify and quantify the linkages between ecosystem services and the dimensions of human well-being, what they mean in different contexts, and for different stakeholders (Carpenter et al., 2009; Daw et al., 2011). The aim of this article is to tease out the links between ecosystem services and human well-being in three agricultural sites in Costa Rica that practice different forms of environmental management. This circumstance offers an interesting opportunity to: First, explore community-

level perceptions of human well-being in areas where livelihoods are tied to the production of provisioning ecosystem services. Community-level perspectives assessing the benefits derived from ecosystem services continue to be rare (exceptions include Berbes-Blazquez (2012), Sandhu & Sandhu (2014), and de Oliveira & Berkes (2014). Instead, ecosystem service assessments tend to emphasize the point of view of disciplinary experts and focus on what can be measured using ecological and economic metrics (Chan et al., 2012). While technocratic assessments of ecosystem services are undoubtedly useful, they may fuel the assumption that increasing ecosystem services results in increases in human welfare in a straightforward manner. In reality, the relationship between the production of ecosystem services and increases in human well-being is complicated and regions that supply global markets with agricultural commodities might be poor despite bringing foreign exchange to their national economy and crops to international consumers. For example, in 2012 banana exports provided $US 822 million of foreign exchange to Costa Rica yet the province of Limón, which produces the bulk of bananas for export ranked among the poorest in the country (PNUD, 2012; CORBANA, 2013). Thus, there is a need to unpack what mediates the transformation of ecosystem services into actual improvements in well-being, especially in the context of rural poverty and a globalized economy. Given the importance of considering equity, access and distribution at the local scale (Daw et al., 2011, Hicks & Cinner, 2014), community-level perceptions from agricultural sites can bring much needed insights.

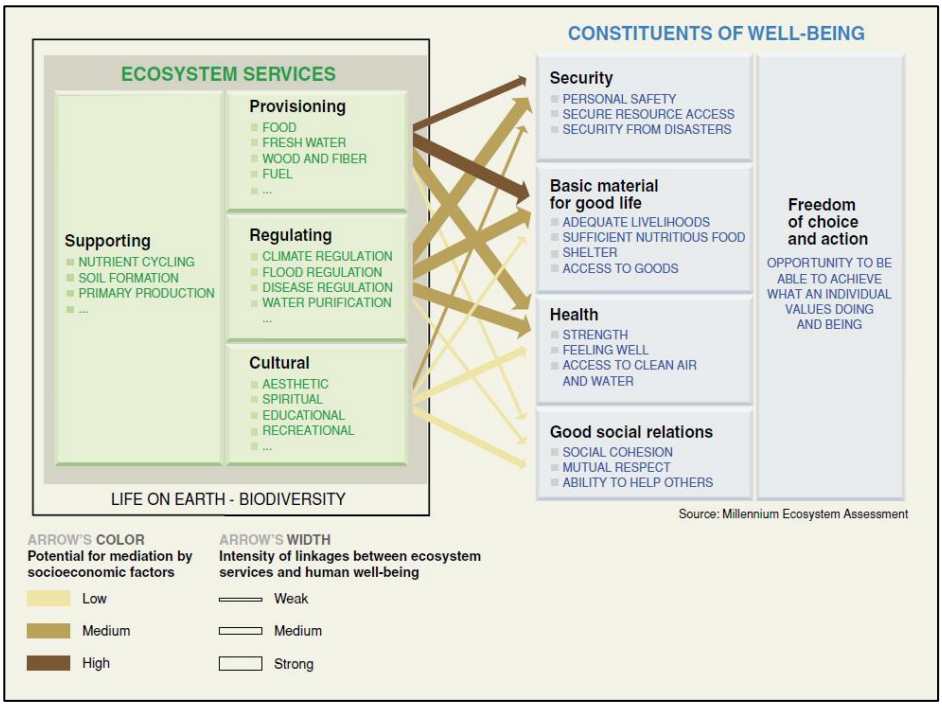


Figure5-1. Relation between ecosystem services and human well-being (MEA, 2003)

Second, examining the links between human well-being and ecosystem services under different forms of agricultural production, offers an opportunity to reflect on the impact on human well-being of alternative management priorities and, by extension, different bundles of ecosystem services. Put simply, any form of decision-making implies choosing among competing alternatives; in the case of natural resource management, managers choose among types of ecosystem services given that not all of the services that an ecosystem produces can be maximized simultaneously (Raudsepp-Hearne et al., 2010). As a result, different agricultural systems can be interpreted as the outcome of applying specific decision-making criteria to the natural environment. Hence, comparing perceptions of human well-being between communities under different forms of agricultural management is a way of exploring how environmental decisions produce trade-offs and what the impact of these trade-offs is on the well-being of agricultural communities. An important aspect of this analysis is to understand

how the different sets of management priorities interact with poverty dynamics to reinforce or reduce the vulnerability of agricultural communities.

The different modes of agricultural production that this article examines are all found on the Caribbean province of Limón in Costa Rica. The county of Matina (Limón), towards the middle of the Caribbean coast, is dominated by large-scale, monoculture banana plantations produced for the international market. The Bribri Indigenous Territory in the county of Talamanca (Limón) to the southeast contains smallholdings where two alternative resource management systems coexist to produce plantains: traditional agroforestry plots that produce a variety of crops (hereafter referred as "traditional" or "organic") and single-species plots of plantain that use various degrees of agrochemical inputs (hereafter referred as "conventional"). While conducting a full ecosystem service assessment is beyond the scope of this study, I rely on Foley et al. (2005), Nelson et al. (2009), or Bennett & Balvanera (2007) to characterize the large-scale monoculture plantations in Matina as the epitome of an agricultural management systems that optimizes a single provisioning service above all others (Rist et al., 2014; Andersson et al., 2015). In contrast, traditional agriculture in the Bribri Indigenous Territory maintains a wider range of ecosystem services simultaneously, including provisioning, regulating and cultural services. Conventional agriculture in the Bribri Territory stands somewhere in between these two extremes, because while the plots are sown with single plant species, they also operate in smaller temporal and spatial scales, which means that the impacts are less and the potential for reversibility is higher than in the case of the large-scale banana plantations. Figure 5-2 displays images of typical agricultural plots in the three areas and the hypothetical degree of trade-offs that each system embodies.

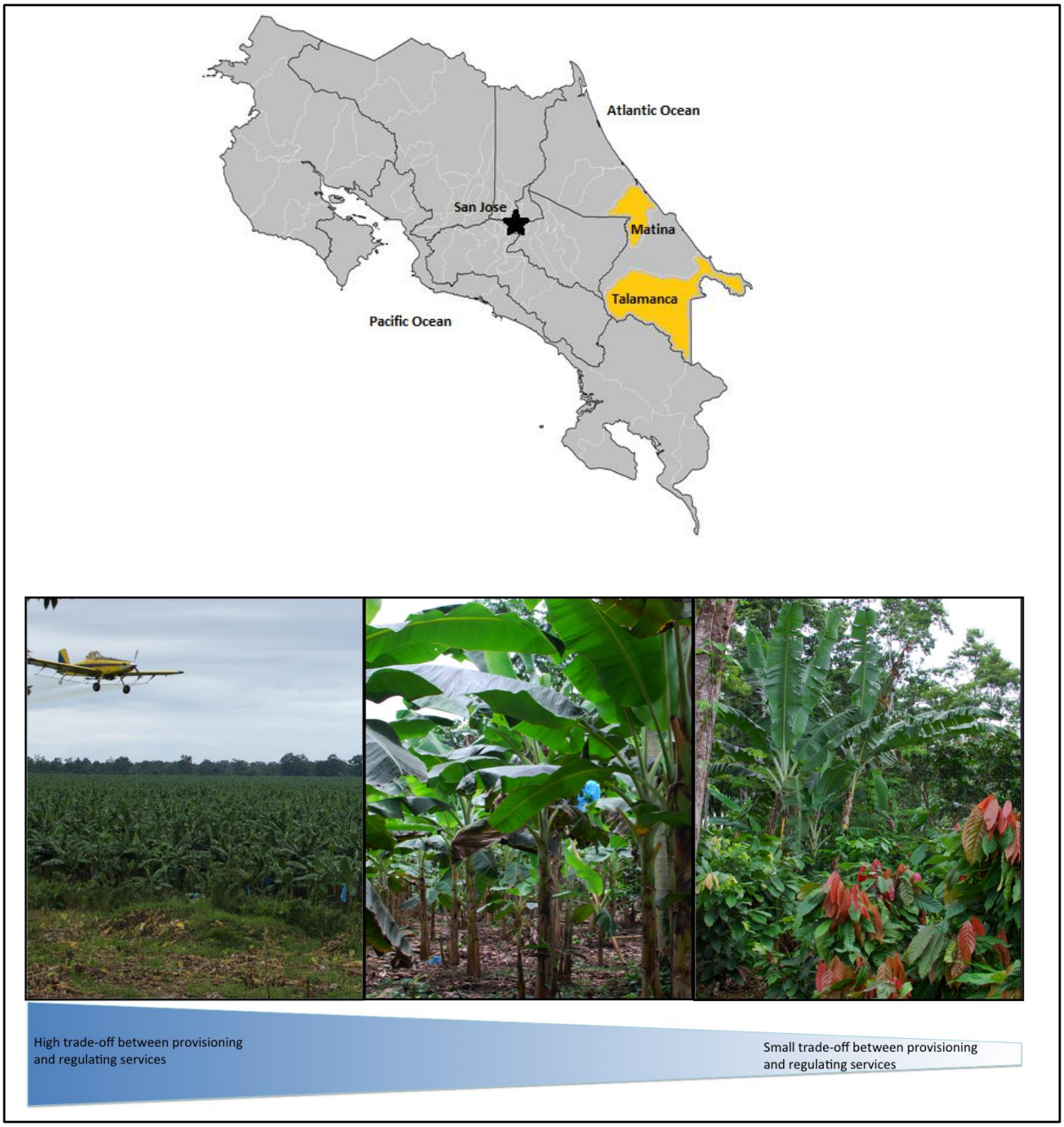


Figure 5-2. Location and typical banana plantation in Matina (left), conventional agriculture in the Bribri Indigenous Territory (middle) and agroforestry in the Bribri Indigenous Territory (right). Source: Author.

Agriculture in Caribbean Costa Rica

The historical trajectory of the province of Limón on the Caribbean coast of Costa Rica has followed a different path from the rest of the country, a circumstance that has conferred this region its own character, and one that is deeply intertwined with the international banana trade. A good entry point into the recent history of Limón is the end of the 19th century, the time when the contract for the construction of the Atlantic Railroad was granted to North American businessman Minor C. Keith. Once the railroad was built, Keith was able to start the commercial banana trade by taking advantage of the generous land concessions and tax incentives provided to him by the government, as well as the surplus of foreign labourers that were brought for the construction of the railroad. Many of these workers were Jamaicans who had agricultural knowledge pertinent to the cultivation of bananas (Marquardt, 2001). In addition to the availability of cheap labour and transportation, the biophysical conditions of the Caribbean coast of Costa Rica are ideal for large-scale banana agriculture. The coastal plains are the alluvial plains of large river systems such as the Matina, Banano or Estrella, which periodically deposit mineral-rich volcanic sediment from the Talamanca mountain range (Hernandez and Witter, 1996). As well, the terrain is flat at an altitude below 200 meters above sea level, the climate is warm and humid, with abundant annual precipitation (3,300 mm on average), and temperatures more or less constant throughout the year between 20-30 °C.

Keith started the first banana commercial operation in Costa Rica in the Zent valley in 1872, which later became the United Fruit Company (UFCO) in 1899. In the beginning, the UFCO did not implement land conservation measures in its plantations, instead it relied on the availability of new lands where mature tropical forest could be fallen to provide the nutrients needed and it abandoned the fields once the soil fertility rendered the plantation unprofitable

(Marquardt, 2001). At its peak the company operated banana plantations throughout Central America from Colombia to Guatemala. Today, the UFCO no longer operates in Limón, fungal diseases have done away with the Gros Michel banana in favour of the Cavendish cultivar, and Hispanic Costa Ricans and Nicaraguan immigrants have replaced the majority of Afro-Costa Rican workers. However, the plantation model continues to dominate agriculture in the flatlands of the province of Limón. Three large companies - Del Monte, Chiquita and Dole - produce 87 percent of the bananas for export (Raynolds, 2003) relying on heavily mechanized, large-scale, monocrop plantations and a cocktail of agrochemicals that includes nematicides, fungicides and herbicides (Wesseling et al., 2001).

The expansion of the UFCO also reached the Talamanca county on the Southeast Caribbean coast of Costa Rica where the Bribri Indigenous Territory is situated. In 1909 the Chiriqui Land Company, a subsidiary of UFCO, sought to expand operations into the Talamanca-Sixaola valley. Land was either expropriated from the Bribris or they were coerced into selling their lands to the company. As a result, many Bribris retreated to the slopes of the Talamanca mountains where agriculture is difficult (Biesanz et al., 1999). However, unusually heavy floods in the 1920s and 1930s, compounded by a series of plagues affecting the banana - notably the fulminating impact of the fungus *fusarium oxysporum,* dubbed the 'Panama disease' - forced the company to abandon operations in the valley in 1938 (Whelan, 2005). Nevertheless, by the time that the company left, there had been lasting modifications to the ecosystem and to the traditional organization of Bribri society through the creation of a labour market that gave a definite push towards the integration of the Territory into the cash economy (Whelan, 2005; Rojas-Conejo 2002). Following the demise of banana production from the Talamanca-Sixaola valley, there was a period where residents returned to subsistence farming as their primary activity supplemented by the sale of cacao. However, with the appearance of monilia (a fungal

disease affecting cacao plants) in 1978, the production of cocoa plummeted by nearly 80 percent and it never recovered (Dahlquist et al., 2007). The impact of monilia, together with the opening of the road between the Bribri Territory and Limón, provided the window of opportunity necessary for the emergence of plantain as an alternative cash crop for Indigenous households.

Research sites

This research focuses on communities surrounding the banana plantations in the county of Matina (Limón) and communities in the Bribri Indigenous Territory in the country of Talamanca (Limón) that produce plantains for the national market. The county of Matina occupies an area of 773 km^2 and it borders with the Talamanca mountain range to the West, the Caribbean Sea to the East, the Madre de Dios River to the North, and the Toro River to the South. The primary economic activity in Matina is large-scale banana agriculture, which in 2012 occupied 9,873 ha of land to produce over 500,000 MT of banana, or nearly a quarter of the national banana production for export destined to North America, Europe and Russia (CORBANA, 2013). Interviews were conducted in the communities of Bataan, Matina, B-Line, Estrada, Zent, 28-Millas and 4-Millas, which are all within a 15 km radius of each other within the Matina River watershed (figure 5-3). Bataan and Matina are larger population centers and count with better infrastructure and services, such as high schools, medical centers, and bus stations. The rest are smaller communities situated further into the plantations.

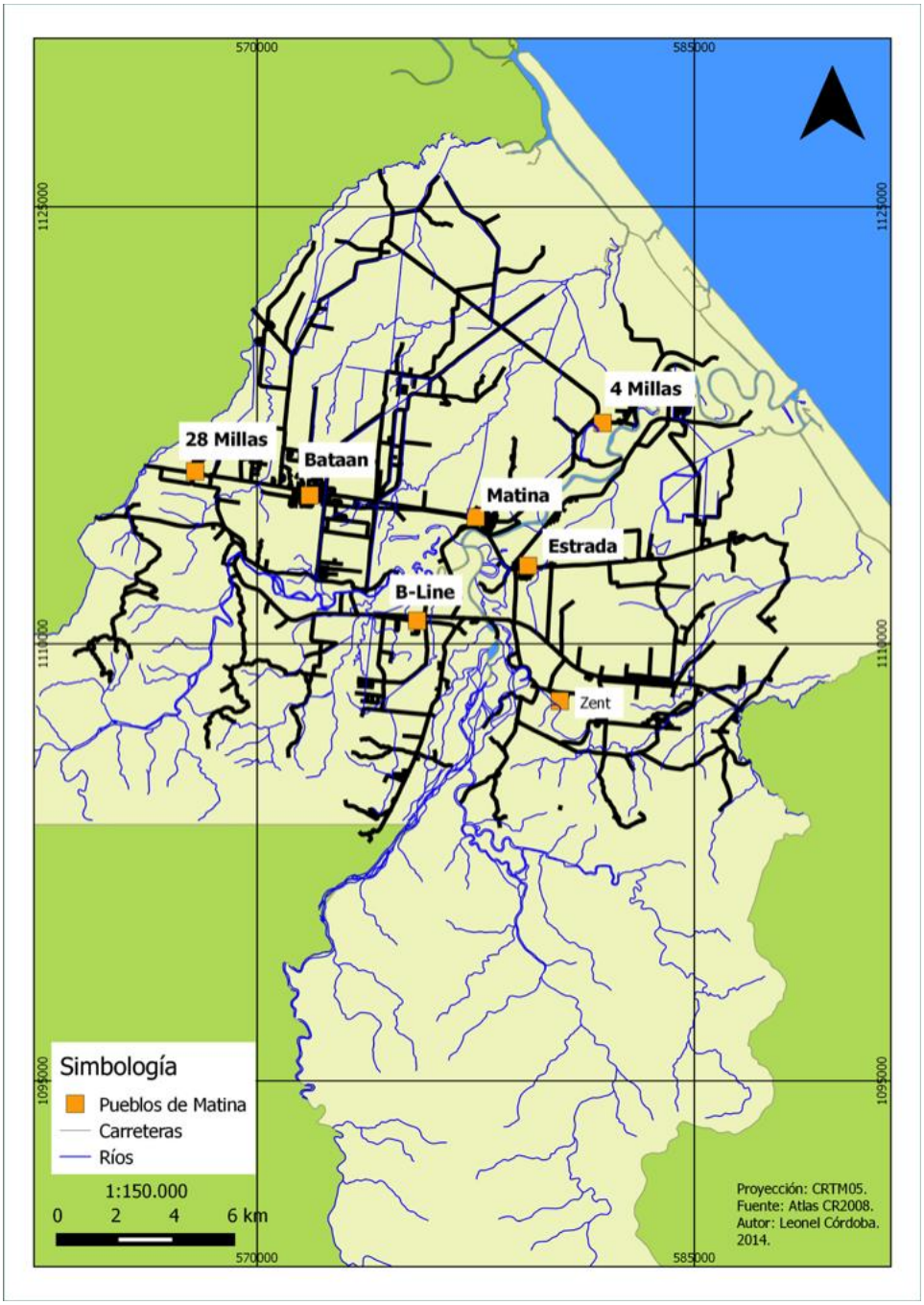


Figure 5-3. Map of communities in the county of Matina where interviews were conducted.

The Bribri Indigenous territory was created as a result of the passing of the Costa Rican Indigenous Law in 1977 and it encompasses 24 communities dispersed over 437 km^2 on the Caribbean slope of the Talamanca mountain range. The Bribri Indigenous Territory is governed

by a local Indigenous government known as the Integrated Indigenous Bribri Development Association of Talamanca, *Asociación del Desarrollo Integral Indígena Bribri de Talamanca* (ADITIBRI, Spanish acronym), which is composed of local representatives elected by Indigenous residents. The territory is part of the Talamanca county, which is one of the largest and most diverse counties in Costa Rica, bordering with Panama to the south, the Caribbean sea to the east, the county of Limón to the north and the counties of Perez Zeledón and Buenos Aires to the west. Talamanca produces 52% of the plantain, 90% of the organic banana, and 6% of the commercial banana production in Costa Rica (Municipality of Talamanca, 2003). Interviews were conducted in three communities in the Bribri Indigenous Territory: Suretka, Shiroles and Amubrë (see figure 5-4), which are within 8 km of each other within the Sixaola-Talamanca River watershed. There are two things to note with respect to these communities: First, Suretka and Shiroles are contiguous so I will refer to them as Suretka-Shiroles. Second, Suretka-Shiroles are situated along the main road connecting the territory with the coast whereas Amubrë is separated from this road by the Telire River, which needs to be crossed by boat. The additional remoteness that comes from this river crossing means that Amubrë has remained sheltered to a higher degree from outside influences. In terms of agriculture, conventional agriculture is more prevalent in Suretka-Shiroles than in Amubrë.

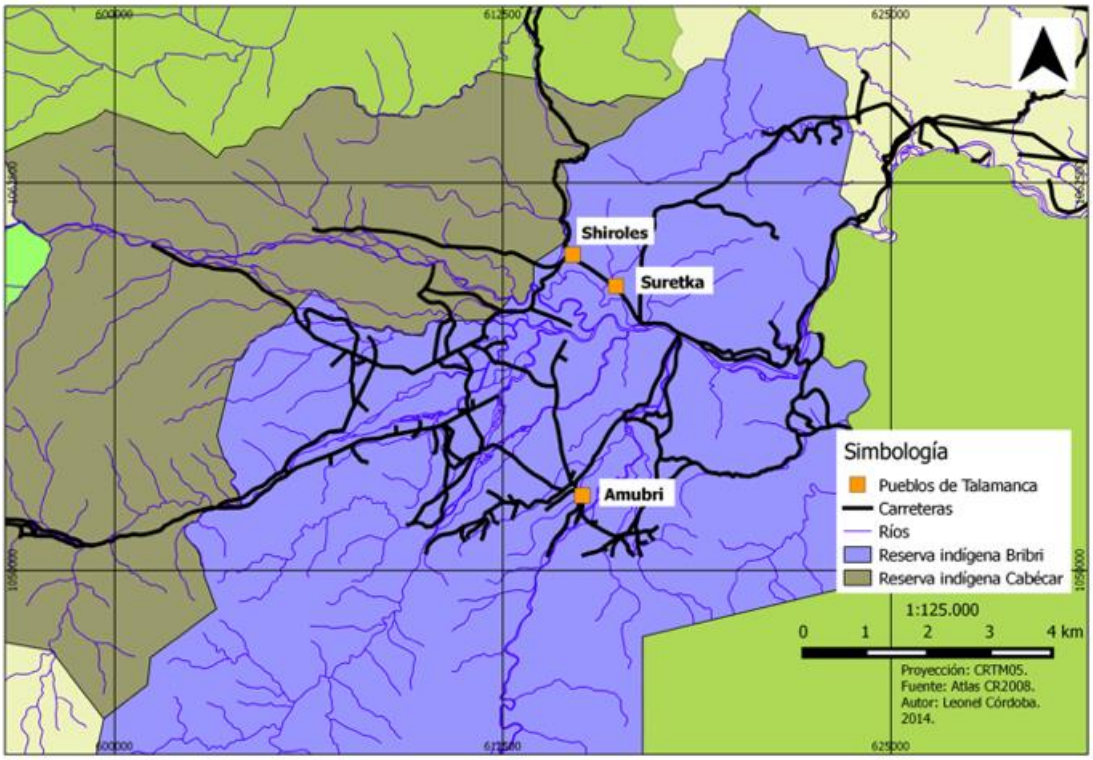


Figure 5-4. Communities in the Bribri Indigenous Territory were interviews were conducted.

Methodology

In this section I explain data collection and data analysis. My inquiry followed a mixed methods approach based primarily on the construction of 71 fuzzy cognitive maps (FCMs) from semi-structured interviews with farmers, plantation workers and their families, 11 key informant interviews with community members (including elders and cooperative leaders) and qualitative observations (see table 5-1).

Table 5-1.
Mixed Methods Employed in This Study and Selected Key References

Method	Description	Key references
Fuzzy cognitive maps (FCMs)	71 fuzzy cognitive maps constructed with farmers, agricultural workers and their families regarding their livelihoods.	Özesmi (2003, 2004), Kok (2009), van Vliet et al. (2010)

Semi-structured interviews	71 semi-structured interviews conducted with farmers, agricultural workers and their families regarding their livelihoods.	Patton (2002), Mason (2009)
Key informant interviews	11 semi-structured interviews conducted with key informants regarding ecosystem management.	Patton (2002)
Field observation	Conducted at the local level over varying amounts of time to gain insights on people's livelihoods and ecosystem management.	Patton (2002), Mason (2009)

Data Collection

This research used stratified purposeful sampling to select participants. Purposeful sampling provides in-depth information about a relatively small number of cases selected purposefully, as opposed to random sampling, which aims to be statistically representative (Patton, 2002). Purposeful sampling was chosen because it allows to explore the uniqueness of demographic groups, as well as to investigate patterns that might emerge across those demographic lines. After considering the alternative perspectives that might be held by the different ecosystem-users living in each study site, I aimed to interview individuals from the groups summarized in table 5-2. In the Bribri Indigenous Territory, I sought to interview males and females in Suretka-Shiroles and males and females in Amubrë. An important detail about gender in the Bribri Indigenous Territory is that the Bribri are a matrilineal society where land and Indigenous status passes from mother to daughter. Indigenous women in the territory are landowners and farmers. In Matina, I sought to interview males and females with the expectation that males were the breadwinners and females were housewives. However, as the interviews progressed, I realized that there was a number of women employed in the plantations as packers who often headed single-parent households, thus they became a separate category. An additional group that was distinct in Matina were the Nicaraguan male plantation workers, who come to the plantations by themselves or with their families.

When constructing FCMs, Özesmi & Özesmi (2004) recommend stopping sampling after the answers begin to converge, that is, no new themes emerge in additional interviews. In my experience conducting semi-structured interviews in communities in Costa Rica, key themes begin to be repeated after interviewing between 8 to 10 people. While I was unable to listen to each interview recording while we were conducting interviews in Matina and Talamanca, my research assistant and I interviewed at least ten people per demographic category.

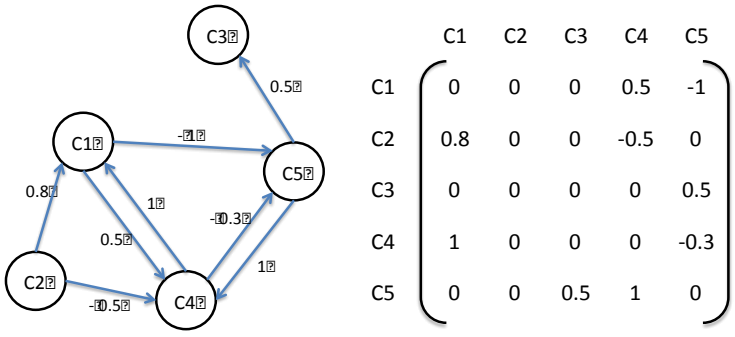
Table 5-2.
Characteristics of the Demographic Groups Sought in Matina and the Bribri Indigenous Territory

Region	Relevant Demographic Categories	Group Description
Matina	Female plantation workers	Female banana plantation workers, usually employed in packing plants. Most are Costa Rican, many are single heads of households.
	Female housewives	Spouses of plantation workers who are housewives or might take odd jobs (sewing, etc.). Mostly Costa Rican.
	Male plantation workers (Costa Rican)	Costa Rican male banana plantation workers usually employed as field workers.
	Male plantation workers (Nicaraguan)	Nicaraguan male banana plantation workers usually employed as field workers, sometimes through a subcontractor. Some were working illegally.
Bribri Indigenous Territory	Indigenous female producers (Suretka/Shiroles)	Indigenous Bribri women whose livelihoods depend on the production of plantain and banana. Some use traditional methods, some use conventional methods.
	Indigenous male producers (Suretka/Shiroles)	Indigenous Bribri men whose livelihoods depend on the production of plantain and banana. Some use traditional methods, some use conventional methods.
	Indigenous female producers (Amubrë)	Indigenous Bribri women whose livelihoods depend on the production of plantain/banana/cocoa. Most use traditional methods.
	Indigenous male producers (Amubrë)	Indigenous Bribri men whose livelihoods depend on the production of plantain/banana/cocoa. Most use traditional methods.

Fuzzy Cognitive Maps (FCMs)

An FCM is a graphical representation of causal links to study how an effect propagates throughout a causal chain (Kosko, 1986). FCMs are a useful tool to explore well-being in rural communities since they are well suited for exploring soft-knowledge domains (Kok, 2009), they

can integrate different types of knowledges and variables (Özesmi & Özesmi, 2004, van Vliet et al., 2010), they can show feedbacks in a system, and they are a good tool for communication between groups of stakeholders (van Vliet et al., 2010). FCMs have vertices or nodes (Ci, Cj… Cn) which represent variables (e.g. salary or exposure to pesticides), that are connected by links called edges or arcs. If an edge is identified with a positive sign, it means that more of Ci causes more of Cj (direct relation), and if the edge is identified with a negative sign, it means that more of Ci causes less of Cj (inverse relation). A number between −1 and +1 indicates the strength of the connection, the larger the number, the stronger the connection. The graphical depictions of FCMs can be represented as an adjacency matrix (see figure 5-5). Individual adjacency matrixes can then be summed to create an augmented matrix reflecting the opinion of a group (Kosko, 1988). The augmented matrix can be further analyzed by calculating the outdegree, indegree and centrality of each node. The outdegree is the sum of all the absolute values within a row of the matrix, that is, the absolute sum of all of the weights of the arrows going out of a node. The indegree is the sum of all the absolute values in a column, that is, the absolute sum of all the weights of the arrows coming into a node. Centrality is the absolute sum of indegree and outdegree. In the hypothetical FCM shown below, node C1 has an outdegree of 1.5, an indegree of 1.8 and a centrality of 3.3.



	C1	C2	C3	C4	C5
C1	0	0	0	0.5	-1
C2	0.8	0	0	-0.5	0
C3	0	0	0	0	0.5
C4	1	0	0	0	-0.3
C5	0	0	0.5	1	0

Figure 5-5. Example of a fuzzy cognitive map (left) with its corresponding adjacency matrix (right)

There are different ways of constructing an FCM. In this case, the FCMs were constructed using semi-structured interviews conducted between August and November 2011 by the author and one Costa Rican research assistant. The interviews were carried out one-on-one using a semi-structured format. Semi-structured interviews have been defined as "conversations with a purpose" (Mason, 2009). The interviews were fairly informal exchanges with the idea of encouraging interviewees to adopt a autobiographical and narrative approach in identifying the factors that shaped their well-being. After explaining to the interviewees that we wanted to construct a "map of ideas" (*mapa de ideas*), the interviewer began by asking the person what they needed to feel well. Once the person gave an initial answer, e.g. an income, the interviewer questioned the person further with probes that elicited further elaboration, e.g. "and what does having an income depend on?" The interviewer insisted in probing questions that highlighted dependency to push participants to think about causality. The interviews were built around the dimensions of human well-being identified by the framework of the MEA (2003), which include material wealth, safety and security, health, and meaningful social relations. Most interviewees covered at least a few of these dimensions on their own, but if they did not, the interviewer would inquiry specifically about them.

As the person started to speak, the interviewer began constructing the FCM on a large piece of flip-chart paper that was placed in front of the interviewee. The interviewer wrote the concepts that were mentioned and drew arrows to indicate how one variable affected another one. For instance, if the person mentioned that their material well-being depended on having a job at the plantation the interviewer drew an arrow linking "job in plantation" to "material well-being" with a "+" sign. There was constant checking in with the interviewee to ensure that the relationship identified in the FCM was indeed what they had meant to say. However, the level of engagement with the actual map varied, sometimes, the person pointed to the map and

used it to explain the relations, other times, the person spoke to the interviewer directly without referring to the map. At the end, the interviewer summarized the relations identified in the map and asked the person if they agreed or if they wanted to change something. The interview concluded when the person did not have anything else to add to the map. Typically interviews lasted 30 minutes, the shortest interviews lasted approximately 15 minutes and the longest interviews went on for over an hour. With their consent, interviews were recorded and a digital photograph of the FCM taken. An example of a finished map is shown in figure 5-6.

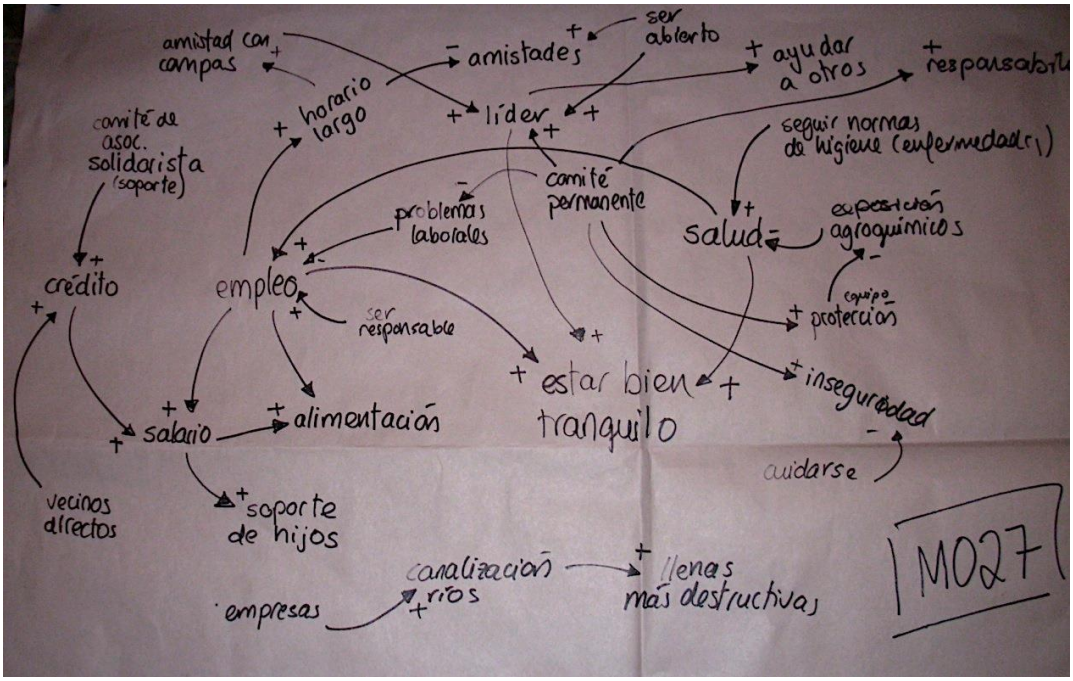


Figure 5-6. A finished FCM constructed with a Nicaraguan worker in B-Line (Matina)

Key Informant Interviews

Key informants are people who are particularly knowledgeable and articulate about a region or a subject and whose insights can be especially useful in interpreting what is happening and why (Patton, 2002). I conducted a number of key informant interviews in each region to gain information about the system of resource management and their perceptions

about well-being in their respective communities. I relied on the guidance and the networks of local researchers from the Central American Institute for Studies on Toxic Substances (IRET, Spanish acronym) to find key informants. Some of the IRET researchers also became key informants. The number of interviews varied in each study site depending on my own familiarity with the setting and the amount of secondary data available (see table 5-3).

Table 5-3.
Roles of Key Informant Interviewees Within Their Communities

Matina	Bribri Indigenous Territory
1 Representative from a women's group	3 Agricultural co-op members
2 Representatives from the Asociación de Desarrollo[1]	2 Ex-representatives from ADITIBRI[2]
1 Researcher from IRET[3]	1 Representative from ADITIBRI
	1 Elder
	1 Researcher from IRET

[1] ADITIBRI: Indigenous Bribri government; [2] Asociación de Desarrollo: Local government for development in small communities; [3] Central American Institute for Studies in Toxic Substances

Field Observations

Field observations encompass a variety of techniques, which involve immersing oneself in a research setting to experience and observe first hand a range of dimensions relative to that setting (Mason, 2009). The reason for doing field observations is that some information cannot be articulated during an interview, instead nuances might be revealed in more sensorial and multidimensional ways (Mason, 2009). There is no prescribed way of doing field observations, in my case, I kept a field diary and took photographs of the research sites. Observations on the Indigenous territory came from several short stays in in the community of Shiroles and visits to Amubrë. Observations on the banana region came from living for a month in the community of Bataan in accommodations shared with local researchers, as well as previous shorter visits. Table 5-4 below summarizes some of the opportunities that I had to do observations in each research site.

Table 5-4.
Summary of Field Observation Opportunities in Matina and the Bribri Indigenous Territory

	Matina	Bribri Indigenous Territory
Time spent	1 month and several short visits	Several short visits (1-2 weeks at time)
Participant – observer	Observer	Observer
Types of community activities observed	Few. Visited women's project, observed nemagon meeting, street band rehearsal	Few. Training for eco-tourism guides. Visits to agricultural cooperatives.
Types of community spaces visited	Market, small restaurants	Market, small restaurants, soccer field
Access to family life	Mostly during interviews. I was invited on occasion to people's homes	Mostly during interviews. I was invited on occasion to people's homes
Access to production sites	Very restricted. Observed plantations from the outside.	Easy access. Visited nearby farms on my own. Guided visits to model farm.

Data Analysis

To create the FCMs, each interview was transcribed (non-verbatim) and coded to identify themes and the relations between them. Coding was an iterative process that involved a first reading of each interview transcript, a round of coding by hand to identify large themes following the dimensions of human well-being from the MEA (2003), a second round of coding using qualitative data analysis software (Atlas.ti) to identify subthemes and relationships that impacted well-being, and a third round of coding to group and reduce the number of factors identified. After this process was completed, there were 55 factors remaining displayed on table 5-5. In the interviews, these factors are actually related to one another; for instance, a person might establish that "behaving well towards others" has a positive influence in building meaningful "social relations". This formed the basis to construct the individual adjacency matrixes, by noting 0 or 1 if the person mentioned a particular relationship. The augmented matrixes for each site were created by adding the adjacency matrixes for individuals in the same demographic group identified in table 5-2. The augmented matrixes are contained in appendix 1. Last, to construct the actual FCMs, I used the free online tool FCMappers, which is a spreadsheet with built-in macros. Once the augmented matrixes from appendix B are input into

FCMappers, the spreadsheet checks for errors (e.g. missing values, self-referential loops) and calculates indegree, outdegree and centrality indexes. FCMappers also produces a text file that can be loaded onto Pajek, a software to visualize networks, to produce the actual FCMs. Appendix C contains the FCMs from each of the demographic groups aforementioned.

Table 5-5.
Factors Affecting Well-Being Identified Through the Coding Process of Semi-Structured Interviews Conducted in Matina and the Bribri Indigenous Territory

Factor	Brief description
Behaving well towards others	A behaviour associated with being respectful, having a good disposition towards others, having good values, speaking to everyone.
Being a good worker	Person mentions that in order to keep their jobs it is important to behave well in the eyes of the company.
Being employed	This factor refers to the need to have wage work to secure the material basics. People often mention how wage work requires having formal education (that they do not have).
Being vigilant	Person mentions that in order to stay safe from crime one needs to be watchful, e.g. don't be out late, walk in groups. The onus is placed on the person staying out of harm's way.
Community projects	Person mentions her involvement in community projects increases her sense of community and strengthens her social relations.
Cost of living	Person complains about the rising cost of living as an impediment to make ends meet. The cost of school materials is specifically singled out.
Decline in agricultural productivity	This factor refers to a feedback loop where poor soil quality increases chemical dependency and chemical dependency decreases soil quality.
Dengue	Person mentions dengue outbreaks as a preoccupation to their health. Haemorrhagic dengue is endemic in Costa Rica and there was a dengue outbreak in Matina while the interviews where being conducted.
Disinformation	This is a factor that appeared only during interviews in the Bribri Indigenous Territory. The person expresses the feeling that as Indigenous people they lack knowledge to manage agrochemicals (thus increasing their exposure) or managing market transactions (thus they need middlemen to take the plantain to the market)
Distrust on governing body	Instances of elite capture, corruption, self-interest, rent-seeking, by members of the local government make people doubt their leadership.
Dubious labour practices	Worker expresses a variety of unfair and likely illegal practices to which s/he's subjected as a plantation worker, e.g. aerial spraying in areas where there are workers, sexual harassment, black-listing, union busting practices.
Economic need (scarcity)	Person feels that they do not have sufficient money to make ends meet ("no alcanza").
Emotional stress	Person mentions not feeling well mentally, emotionally, being excessively preoccupied, worried about money, feeling stressed, marital problems, not sleeping at night.
Environmental degradation	This can take many forms: contamination of water ways, land use change, pollution, mining prospecting (in the Bribri Indigenous Territory), river channelling and so on.

Exposure to agrochemicals	Person mentions how exposure to agrochemicals affects their health. They may mention chronic or acute health effects.
Family breakdown	This factor refers to anything from marital tensions to the impact of drugs on families to the difficulty of raising children while working long hours.
Fatigue	Fatigue is associated with physical exhaustion. It is often associated with piece work and long work hours at the plantations.
Feeling healthy	Feeling healthy is one of the dimensions of human well-being identified in the MEA (2003)
Feeling safe	Feeling safe is one of the dimensions of human well-being identified in MEA (2003)
Floods	This factor refers to the regular flooding that experience these areas. Flooding causes both material damages and brings waterborne diseases.
Having good social relations	Having social relations is one of the dimensions of human well-being identified in the MEA (2003).
Having the materials for good life	Having the materials for a good life (food, shelter and clothing) is one of the dimensions of human well-being identified in the MEA (2003).
Impunity (soft laws)	Person mentions that laws are soft, that criminals are released right away, or police force inadequate or corrupt, as factors that make them feel unsafe. Some mention that there's a code of silence.
In-kind payment of basic needs	Person mentions that they depend on the company to provide them with basic needs such as housing and potable water because they live in worker quarters.
Intensive agriculture	Refers to the switch from traditional to conventional agriculture in the Bribri Indigenous Territory.
Keeping to oneself	Person mentions that they prefer not to be too involved as a way of ensuring good social relations (not meddling in other people's business). It is also a way of staying out of trouble. It denotes some degree of indifference towards the community.
Knowing people in community	The person states that knowing other community members makes them feel that they relate well. They also feel safer.
Lack of time	Person mentions that they lack of time to invest in creating or maintaining social relations, usually in relation with very long work hours.
Land pressures	Person is unable to grow their own food because they do not have sufficient land to plant vegetables for self-consumption.
Low price of crop	Producers point out that the sale price of the crop is simply not enough to satisfy their economic needs
Neighbourhood watch	Person mentions that their neighbours watch their homes when they are away, or a similar form of community neighbourhood watch, which makes them feel safe.
New diseases	Person mentions the appearance of new chronic diseases (e.g. heart conditions, cancer, diabetes) as negatively impacting their health. It is usually tied to lifestyle/diet change.
Outside influences	Any of the mechanisms by which non-Indigenous influences are felt in the territory. These range from the establishment of the Costa Rican educational system to more subtle influences on lifestyle.
Personal protection equipment	Worker mentions that how they feel protected from agrochemical exposure because they are provided with personal protection equipment
Piece work	Piece work means that workers are paid by unit of work rather than by hour of work. This is usually tied to long hours and to physical exhaustion.
Population pressures	An increasing population puts additional pressure on natural resources in the Bribri Indigenous Territory

Presence of banana companies	Banana companies are one of the few sources of employment in Matina
Presence of cooperatives	Cooperatives operate in the Bribri Indigenous Territory and they purchase plantain grown using traditional agriculture.
Presence of crime	Person mentions the presence of petty crime, such as assaults and robberies, make people feel unsafe. In Matina, people also mentioned violent crimes, such as homicides and shootings.
Presence of drug traffic	Person indicates that the presence of drug traffic and consumption increases the occurrence of crime in the region.
Presence of middlemen	Producers denounce the presence of middlemen that they see as extremely exploitative, particularly regarding price fixing.
Pressure on resources from outside	Demand for timber, mining prospecting, eco-tourism by non-Indigenous people and/or institutions.
Push to traditional agriculture	Factors that encourage traditional farming practices
Relations with co-workers	Work colleagues are part of the social circle or circle of acquaintances
Self-sufficiency	Person mentions self-sufficiency (household vegetables/animals) as a component of their economic well-being.
Sense of unfairness/exploitation	Person mentions how they feel that they are being taken advantage of, undervalued or exploited.
Social isolation	Person mentions how they feel isolated from the community, either because they lack time to socialize or because they are suspicious of others
Stolen production	Person reports having had their produce stolen from their farmstead
Traditional diet	The diet that was traditional in the territory made people stay healthy, whereas the new diet that comes from changing lifestyles causes "new" diseases (e.g. cancer, diabetes).
Traditional medicine	Person mentions the use of traditional medicine and rituals as helping them to stay healthy.
Traditional values	Part of Bribri identity and usually associated with a sense of respect for tradition and duty towards the community.
Transient population	Person mentions that the presence of semi-migrant workers and immigrant workers makes it difficulty to develop a sense of community.
Unoccupied youth	People mention that the presence of teenagers without work and who don't go to school increases the amount of petty crime in the region. This concern is particularly acute among single-headed households.
Variable income	Fluctuations in income that make it difficult to plan expenses
Work accidents	Worker reports work accidents or quasi-accidents that have had an impact on their health. In many cases, the worker has not been compensated.

Results

Demographic Characteristics of the Interview Groups

Table 5-6 displays the demographic profiles of the group of interviewees from Matina (n=29). It should be noted that there were 50 semi-structured interviews conducted in Matina but 17 respondents declined to be recorded and four interviews were impossible to transcribe due to poor sound quality or corrupted files. The unusually high percentage of respondents that declined being recorded (34 percent) may be indicative of the fear that workers have of losing their job if they are perceived as speaking up against the banana companies. While these conversations did not become FCMs, they still have influenced the interpretation of results. The dataset that informs the FCMs in Matina is made up of almost an equal number of males and females from seven communities: 4-Millas, 28-Millas, B-Line, Bataan, Estrada, Matina and Zent. The majority of the interviewees owned or rented a house, but seven of them lived in worker's quarters. The worker quarters are fenced-in spaces provided by a company containing rows of identical houses that workers are allowed to occupy - with their families or on their own - while they are employed. We interviewed mostly plantation workers –Costa Rican males, Nicaraguan males and Costa Rican females – and 6 housewives. Among the workers, 65 percent had a permanent contract that allows them to enjoy higher job security and some additional benefits, such as medical insurance. Companies also hire temporary workers who are employed for short periods (typically three months), and are then let go without compensation for a month to be subsequently re-hired for another short period. There is a third group of workers who are hired through a subcontractor. Working with subcontractors exposes workers to more exploitative labour conditions, for instance, subcontractors do not provide medical insurance, they might pay less, and they tend to hire workers for low-skill, physically-

demanding tasks such as digging canals. However, working through a subcontractor does not appear as a separate category because it tends to be a temporary arrangement, many temporary workers do it in their time off, and it is the only option available to those who cannot work legally in country, thus it is likely underreported. Finally, a third of the interviewees came from Nicaragua.

Table 5-6.
Demographic Information Of Interview Respondents In The Communities Surrounding The Banana Plantations Of Matina

Gender	Males	15
	Females	14
Average age	Males	41
	Females	30
Communities	4-Millas	2
	28-Millas	1
	B-Line	11
	Batan	7
	Estrada	3
	Matina	3
	Zent	2
House arrangement	Worker's quarters	7
	Own house	22
Workplace	Housewife	6
	Banana plantation	23
	With contract	13
	Without a contract	10
Country of birth	Costa Rica	19
	Nicaragua/Panama	10

Table 5-7 displays the demographic information collected from respondents in the Bribri Indigenous Territory (n=38). Initially, there were 41 interviews but two were discarded because of corrupt files or poor sound quality and one was discarded because the person was non-Indigenous. The interviews in the Bribri Indigenous Territory were conducted in the communities of Shiroles, Suretka and Amubrë, all of whom self-identified as Bribri. The majority of those interviewed owned land. It is common for the Bribri to have several plots of land in different areas and for different purposes, e.g. plots at higher altitude are kept as forest

for conservation purposes or for hunting, plots on the riverside are used for plantain and banana agriculture. Among the 29 farmers who disclosed the size of their holdings, 31% owned less than 2 ha, 59% owned between 2 and 10 ha, and 10% owned more than 10 ha.

Table 5-7.
Demographic Information Of Interview Respondents In The Bribri Indigenous Territory

Gender	Males	20
	Females	18
Age	Males	42.4
	Females	40.7
Community	Suretka-Shiroles	19
	Amubrë	19
Landownerships	Landowners	33
	Not landowners	5
Size of land (ha)	Less than 2 ha	9
	Between 2 – 10 ha	17
	More than 10 ha	3

Human Well-Being In Agricultural Communities

Below are the FCMs for Matina (n=29), Suretka-Shiroles (n=19) and Amubrë (n=19), as well as table 5-8 containing the centrality indexes. Additional FCMs for each of the demographic sub-groups identified in table 5-2 can be found in appendixes 5.1 and 5.2. In the FCMs presented the nodes represent the factors that respondents associated with their well-being. The size of the nodes correlates with the centrality of the factor, hence the bigger the circle, the higher its centrality. The nodes are coloured according to the dimension of human well-being to which they correspond more closely hence, yellow nodes are related to health, turquoise nodes are related to material well-being, dark blue nodes are related to feeling safe, orange nodes are related to having meaningful social relations, brown nodes are related to mentions of governance, and green nodes are related to environmental matters. These categories came out of the coding process and they are based on the MEA framework to which I

added the last two. The arrows linking the nodes represent the relations that interviewees identified. Solid lines indicate a direct relationship between two factors, e.g. in figure 5-7 interviewees pointed that the "increased presence of banana companies increases the exposure to pesticides"; whereas broken lines indicate an indirect relationship, e.g. in the same figure interviewees also indicated that "increased exposure to pesticides decreases their health". The weight of the arrows indicates the strength of the relationship, that is, the darker the arrow, the higher the number of respondents that identified the relationship. For example in figure 5-7, more respondents identified "keeping to oneself" as contributing to their social relations than they identified "relations with co-workers". It is important to keep in mind that FCMs capture the *beliefs* held by a group and do not necessarily represent the truth in an objective manner. Hence, the FCMs could be missing links that many would consider obvious and have links that many would consider questionable. The point is that the FCMs reflect the perceptions of well-being held by a group that shares certain demographic characteristics.

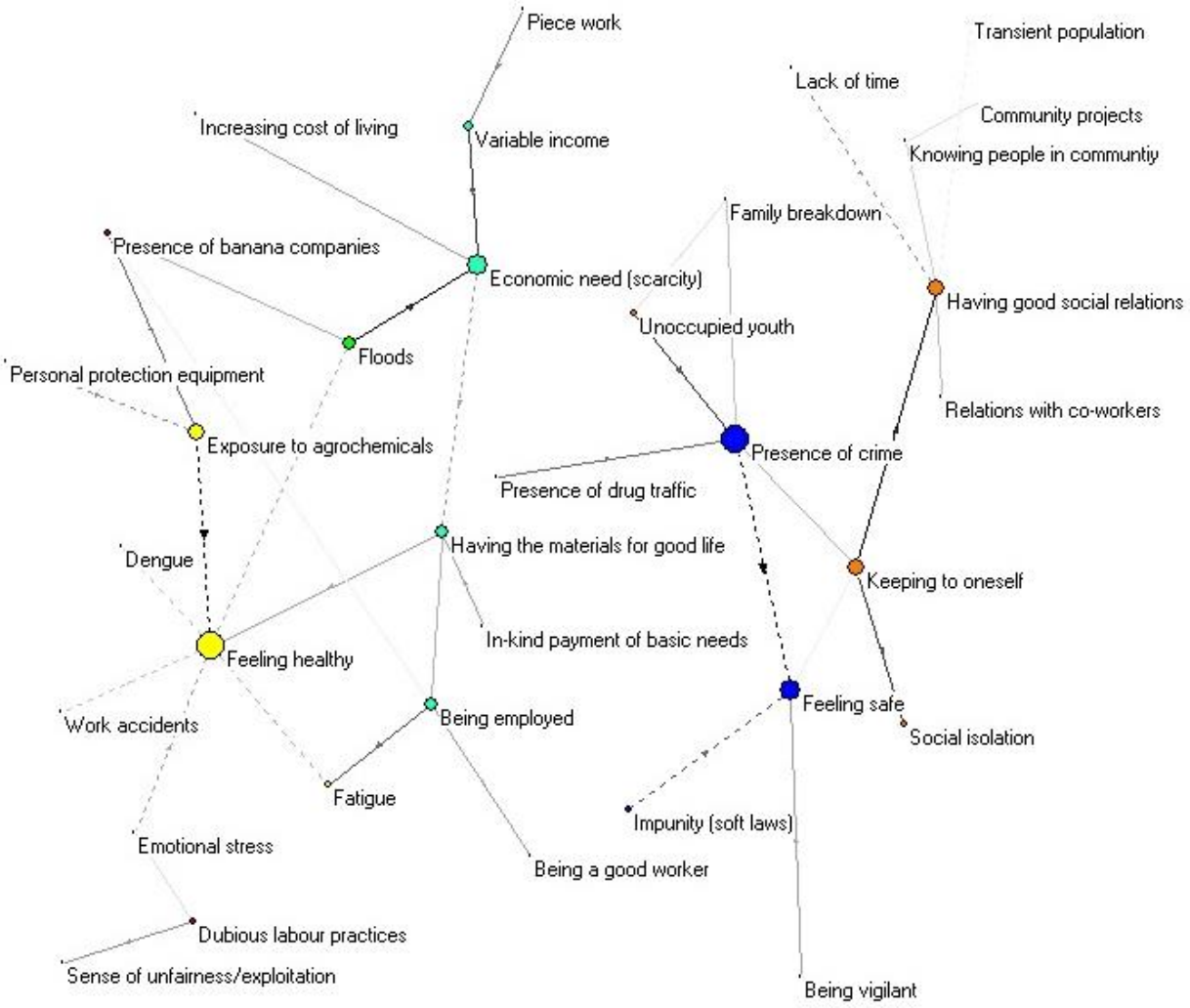


Figure 5-7. FCM representing the factors that impact the well-being of banana plantation workers and their families in Matina. The size of the nodes indicates the centrality (the bigger, the higher the centrality). The colour of the nodes indicates the dimension of human well-being more closely associated with that factor (yellow is health, dark blue is safety, green is environment, turquoise is material well-being, orange is social relations. brown is governance). Solid lines indicate a direct relationship between two nodes, whereas broken lines indicate an inverse relationship. Darker arrows indicate a stronger link, grey arrows indicate a weaker link.

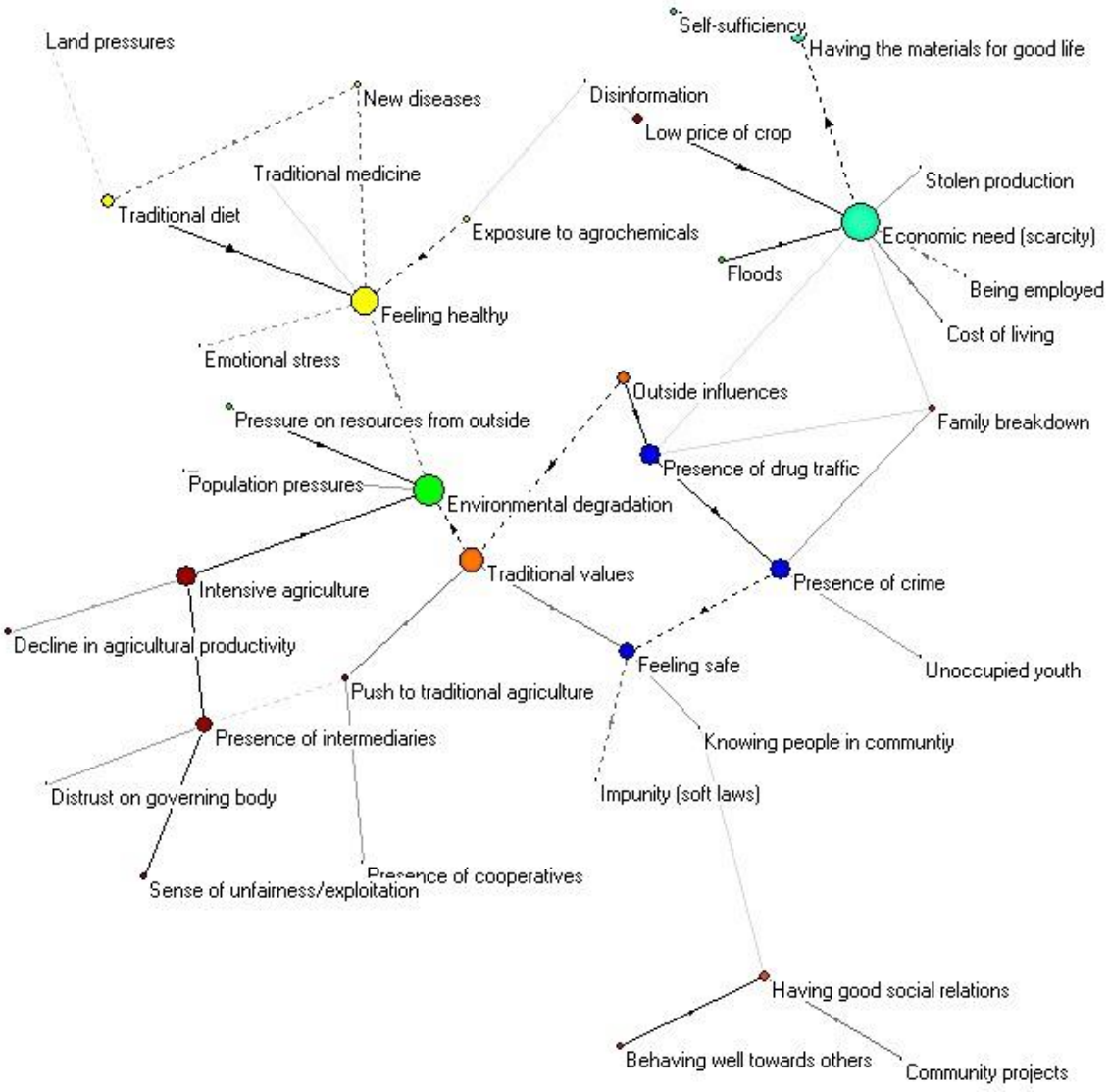


Figure 5-8. FCM representing the factors that impact the well-being of Indigenous plantain producers in Amubrë. The size of the nodes indicates the centrality (the bigger, the higher the centrality). The colour of the nodes indicates the dimension of human well-being more closely associated with that factor (yellow is health, dark blue is safety, green is environment, turquoise is material well-being, orange is social relations. brown is governance). Solid lines indicate a direct relationship between two nodes, whereas broken lines indicate an inverse relationship. Darker arrows indicate a stronger link, grey arrows indicate a weaker link.

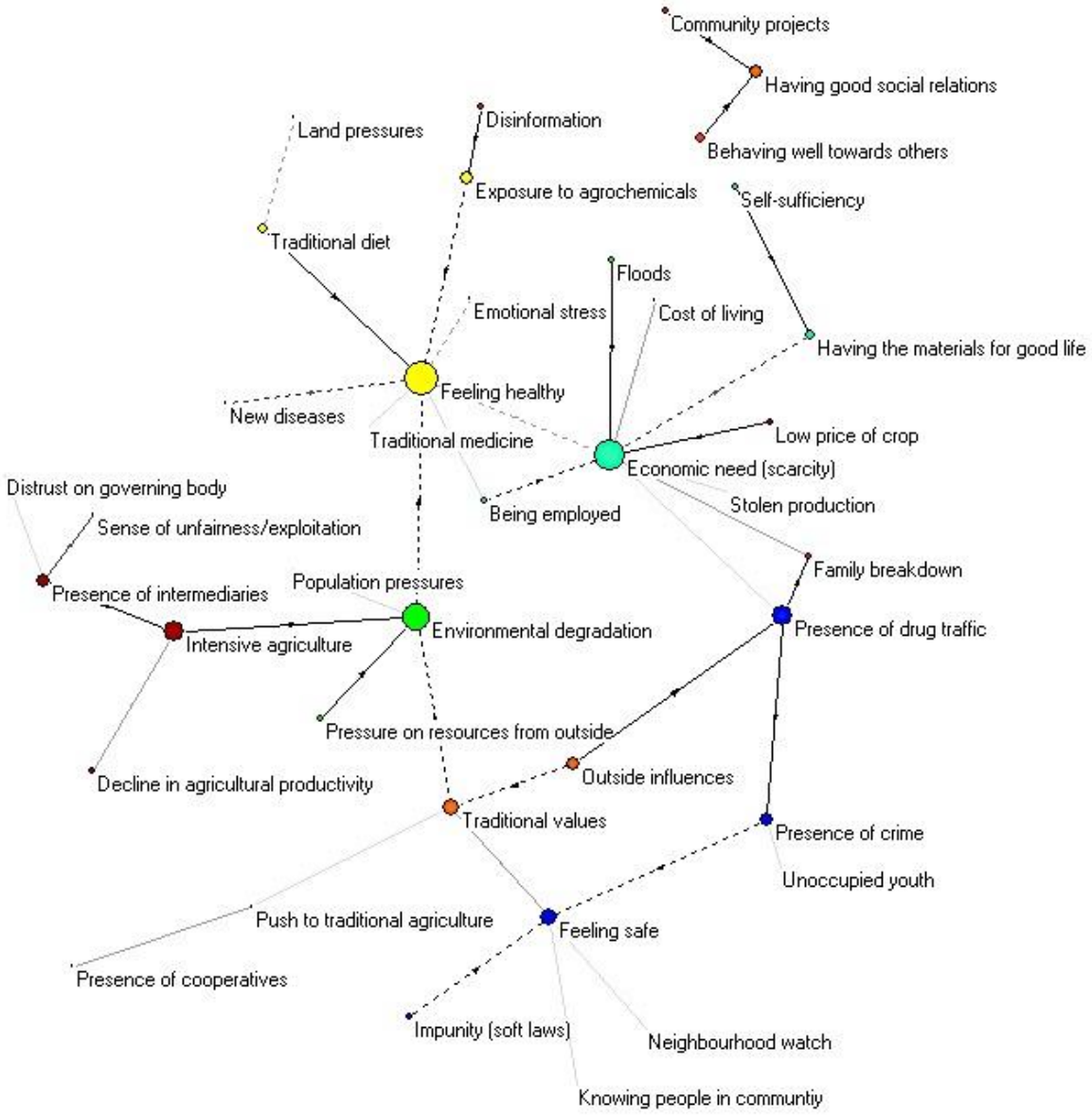


Figure 5-9. FCM representing the factors that impact the well-being of Indigenous plantain producers in Suretka-Shiroles. The size of the nodes indicates the centrality (the bigger, the higher the centrality). The colour of the nodes indicates the dimension of human well-being more closely associated with that factor (yellow is health, dark blue is safety, green is environment, turquoise is material well-being, orange is social relations. brown is governance). Solid lines indicate a direct relationship between two nodes, whereas broken lines indicate an inverse relationship. Darker arrows indicate a stronger link, grey arrows indicate a weaker link.

Table 5-8.
Centrality Index For Each Factor In Matina, Suretka-Shiroles And Amubrë (in bold) and Associated Demographic Sub-Groups.

	Matina	Female Homeworkers	Female Workers	Male Costa Rican Workers	Male Nicaraguan Workers	**Suretka**	Suretka Females	Suretka Males	**Amubrë**	Amubrë Females	Amubrë Males
Behaving well towards others	**--**	--	--	--	--	**0.70**	0.80	0.60	**0.40**	0.10	0.70
Being a good worker	**0.24**	--	0.13	0.38	0.43	**--**	--	--	**--**	--	--
Being employed	**0.90**	0.51	0.76	1.13	1.14	**0.50**	1.10		**0.30**	0.40	0.20
Being vigilant	**0.24**	0.33	0.25	0.38	--	**--**	--	--	**--**	--	--
Community projects	**0.10**	--	--	0.38	--	**0.40**	0.30	0.40	**0.30**	0.60	--
Cost of living	**0.24**	--	0.25	0.25	0.43	**0.20**	0.20	0.20	**0.30**	0.60	0.10
Decline in agricultural productivity	**--**	--	--	--	--	**0.40**	0.30	0.40	**0.40**	0.40	0.30
Dengue	**0.17**	0.50	0.25	--	--	**--**	--	--	**--**	--	--
Disinformation	**--**	--	--	--	--	**0.40**	0.60	0.30	**0.20**	0.10	0.30
Distrust on governing body	**--**	--	--	--	--	**0.10**	--	0.10	**0.20**	--	0.40
Dubious labour practices	**0.38**	0.17	0.63	0.13	0.57	**--**	--	--	**--**	--	--
Economic need (scarcity)	**1.45**	1.34	1.50	1.51	1.43	**2.30**	2.40	1.80	**2.80**	3.40	2.30
Emotional stress	**0.34**	0.50	0.38	0.38	0.14	**0.20**	0.40	--	**0.20**	0.30	--
Environmental degradation	**--**	--	--	--	--	**2.10**	2.20	2.00	**2.30**	2.00	2.50
Exposure to agrochemicals	**1.28**	0.66	1.51	1.38	1.43	**0.90**	1.30	0.60	**0.50**	0.30	0.70
Family breakdown	**0.27**	0.33	0.63	--	0.14	**0.60**	0.70	0.40	**0.40**	0.60	0.20
Fatigue	**0.59**	0.17	0.76	0.88	0.43	**--**	--	--	**--**	--	--
Feeling healthy	**1.90**	2.00	1.90	2.14	1.57	**2.40**	3.00	1.10	**2.00**	2.00	1.80
Feeling safe	**1.48**	1.66	1.13	2.13	1.01	**1.20**	1.20	1.10	**1.30**	1.00	1.40
Floods	**0.94**	1.01	1.13	1.01	0.57	**0.40**	0.20	1.10	**0.40**	0.60	0.30
Having good social relations	**1.18**	0.84	1.27	1.26	1.30	**1.10**	1.10	1.00	**0.80**	0.70	0.90
Having the materials for good life	**0.93**	0.84	0.26	1.88	0.71	**0.70**	0.70	0.60	**1.30**	1.30	1.10
Impunity (soft laws)	**0.41**	0.50	0.13	0.75	0.29	**0.40**	0.30	0.50	**0.30**	--	0.70
In-kind payment of basic needs	**0.24**	0.17	0.13	0.50	0.14	**--**	--	--	**--**	--	--
Intensive agriculture	**--**	--	--	--	--	**1.60**	1.80	1.40	**1.40**	0.90	1.70
Keeping to oneself	**1.25**	1.33	1.51	0.76	1.44	**--**	--	--	**--**	--	--
Knowing people in community	**0.24**	--	0.13	0.51	0.29	**0.10**	--	0.20	**0.30**	0.30	0.20
Lack of time	**0.28**	0.17	0.38	0.25	0.29	**--**	--	--	**--**	--	--
Land pressures	**--**	--	--	--	--	**0.20**	0.30	--	**0.10**	0.20	--
Low price of crop	**--**	--	--	--	--	**0.40**	0.10	0.70	**0.70**	0.30	1.00
Neighbourhood watch	**--**	--	--	--	--	**0.10**	--	0.20	**--**	--	--
New diseases	**--**	--	--	--	--	**0.30**	0.20	0.30	**0.60**	1.20	--
Outside influences	**--**	--	--	--	--	**1.10**	1.40	0.90	**1.00**	0.80	1.10
Personal protection equipment	**0.28**	--	0.50	--	0.57	**--**	--	--	**--**	--	--
Piece work	**0.31**	0.33	0.25	0.25	0.43	**--**	--	--	**--**	--	--

Population pressures	**--**	--	--	--	--	**0.10**	--	0.20	**0.20**	0.10	0.20
Presence of banana companies	**0.62**	0.67	0.38	0.88	0.57	**--**	--	--	**--**	--	--
Presence of cooperatives	**--**	--	--	--	--	**0.20**	0.20	0.10	**0.20**	0.30	0.10
Presence of crime	**1.93**	2.32	2.13	1.88	1.44	**1.00**	1.30	0.70	**1.60**	2.00	1.20
Presence of drug traffic	**0.34**	0.33	0.38	0.38	0.29	**1.60**	1.60	1.60	**1.40**	0.80	1.90
Presence of intermediaries	**--**	--	--	--	--	**1.00**	0.70	1.20	**1.30**	0.50	1.80
Pressure on resources from outside	**--**	--	--	--	--	**0.40**	0.60	0.20	**0.50**	0.60	0.40
Push to traditional agriculture	**--**	--	--	--	--	**0.30**	0.20	0.30	**0.60**	0.60	0.30
Relations with co-workers	**0.17**	0.17		0.25	0.29	**--**	--	--	**--**	--	--
Self-sufficiency	**--**	--	--	--	--	**0.40**	0.40	0.40	**0.50**	0.40	0.40
Sense of unfairness/exploitation	**0.28**	--	0.38	0.13	0.57	**0.30**		0.50	**0.60**	0.40	0.80
Social isolation	**0.45**	0.50	0.63	0.13	0.57	**--**	--	--	**--**	--	--
Stolen production	**--**	--	--	--	--	**0.10**	0.10	0.10	**0.20**	0.40	--
Traditional diet	**--**	--	--	--	--	**0.70**	0.90	0.40	**1.10**	1.50	0.70
Traditional medicine	**--**	--	--	--	--	**0.10**	0.10	0.10	**0.10**	0.10	0.10
Traditional values	**--**	--	--	--	--	**1.30**	1.40	1.10	**1.80**	1.80	1.60
Transient population	**0.07**	--	0.13	--	0.14	**--**	--	--	**--**	--	--
Unoccupied youth	**0.55**	0.50	0.88	0.50	0.29	**0.10**	0.10	--	**0.20**	0.40	--
Variable income	**0.76**	1.00	0.75	0.25	1.14	**--**	--	--	**--**	--	--
Work accidents	**0.17**	0.17	0.25	--	0.29	**--**	--	--	**--**	--	--

The following explanation of results pertains to the FCMs of the three regions above (figure 5-7, 5-8 and 5-9), however I also refer to the maps of the subgroups (contained in appendixes 5.1 and 5.2) to point out to specific nuances on how groups might construct well-being differently. In what follows, the numbers in brackets express the centrality value for a node, e.g. presence of crime (1.93). Centrality values need to be interpreted in relation to one another (Bachhofer, 2014 personal communication). For instance, it may be interesting that in the FCMs for the four Indigenous sub-groups "traditional medicine" has the same centrality and that this is a relatively low value. Or that "traditional medicine" is relatively less important than following a "traditional diet". Note that in discussing FCMS, the dimensions of well-being that guided the semi-structured interviews - health, material well-being, safety and social relations - emerge among the top variables in terms of centrality and indegree because interviewees

related their answers back to the questions that were posed to them. The numbers preceded by positive or negative signs contain information about the arrows joining the nodes, that is, they represent the magnitude and the direction of the arrow, e.g. drug traffic increases crime by +0.34, soft laws decrease the feeling of safety by -0.41. In interpreting the weights of the arrows, one needs to remember that these values have been normalized, so their absolute value ranges between 0 and 1. To simplify the interpretation of results one could consider that strong drivers have absolute values between 0.8 and 1.0, medium-strength drivers have absolute values between 0.5 and 0.7, and weak drivers have absolute values of 0.4 and less (van Vliet 2010, personal communication).

Human well-being in communities surrounding banana plantations. The FCM for the region of Matina shows that the variables that affect human well-being are organized into two groups, one involving factors that impact safety and social relations, and the other involving factors that impact health and economic well-being. The top five variables in terms of centrality in the FCM for Matina are: presence of crime (1.93), health (1.90), feeling safe (1.48), economic need (1.45) and exposure to agrochemicals (1.28). Hence, matters concerning safety and health are the primary concerns of residents around the banana plantations.

In terms of safety and security, the concern over crime is the most salient aspect and it has highest centrality among the women. Crime in Matina is seen as a product of several interrelated and reinforcing factors, namely, the drug traffic, unoccupied youth and family breakdown. Residents conveyed that the lack of programs, resources and infrastructure for youth, together with the lack of parental supervision pushes young teenagers to illicit activities, such as petty crime, gangs and drug trafficking. The link with family breakdown was meant to point to the large amount of time that children spend unsupervised because of the long

workdays at the plantations, especially in the case of single-headed households. A female plantation worker explained (M034)

> *"Think, what happens to a mother who is the entire day at the packing factory? […] What's going to happen to her teenage children? To put it to you, juvenile delinquents grow by themselves. Because there aren't any other options. The moms who are single say, 'either I stay home to take care of my children or I go to work. If I stay home, they'll go hungry, so I'm going to feed them."*

In addition to crime, residents expressed a generalized distrust on the ability of law and order authorities to intervene effectively. For example, residents felt that the law was excessively soft on crime, which allowed criminals to act with impunity. Consequently, the strategies to combat crime that residents of Matina mentioned placed the responsibility of keeping safe on the individual, that is, to avoid being the victim of crime one should be vigilant, keep to oneself, and follow precautions that limit one's exposure. For instance, residents mentioned that one should stay indoors after dark, avoid certain streets, or walk in groups to and from work. A Costa Rican male summarized (M004):

> *"You have to be careful when you go out. Do everything early. Don't expose yourself so that they assault you. If you can, always leave someone at the house. Don't give them the chance to steal from you. Don't expose yourself, if you go to Bataan at night, they will assault you. You need to do everything early so that you don't expose yourself"*

While the above strategies protect the individual, people also become more isolated. Indeed, residents in Matina seemed to have limited social networks. For instance, keeping to oneself (1.25), in the sense of maintaining a respectful distance from other people's affairs, was

seen as a good way of conducting oneself socially. There were other factors impacting social relations that had lower centrality. For example, residents mentioned that knowing others in the community contributed to having good social relations. This usually meant knowing their immediate neighbours or those living on the same street. Being involved with community projects and initiatives was a factor that helped to know people but residents found that they could not make the time to participate. A worker explained: *"It's simple, we leave here at 3 AM or 4 AM. At 4 AM there are no friends to be found on the street, and we return at around 5, or 6 or 7 PM. Hence, it is hard to make friends"* (M027). Adding to the lack of time, some in these communities mentioned the added difficulty of finding a common identity because there is a proportion of the population that is transient, particularly in those communities that are made up of worker quarters.

Last, residents spoke of the relations with co-workers (0.17), which had higher centrality among the Costa Rican male workers. Yet, there was a degree of ambivalence with respect to the relations established through work. While some felt a lot of camaraderie with their fellow workers and see them as a source of support, others expressed a certain suspicion that prevented them from becoming close to their co-workers. For instance, a Nicaraguan male explained (M025) *"I do have acquaintances, people that I've worked with for a long time. But you can't go talking, even if you have known the person for a while, you can't… We can't go talking about issues, like vindicating things."* The suspicion that workers expressed about one another can be explained by the precarious labour conditions that many have and by the notorious "red lists" that companies use to weed out those involved in union activity.

With regards to material well-being, the factors that contributed to material wealth in the communities of Matina were related to employment in the banana plantations. Hence,

positive contributions to the material well-being of residents in Matina came from being employed (+0.17) and from having access to worker quarters provided by the company (+0.24). Access to company-sponsored housing is at the company's discretion and it is usually reserved for workers with permanent contracts. Although worker quarters provide only the most basic accommodations, and in some quarters there were recurrent water quality problems, those interviewed were often appreciative of this living arrangement because it reduced their living expenses. Given the dependency on the company, "being a good worker" was mentioned as a factor that helped to keep one's employment and that related to their ability to secure material goods. Workers explained that being a good worker involved being dutiful (e.g. "not missing a day", "doing the tasks well") and compliant, e.g. staying away from labour unions.

Residents in Matina felt some degree of economic scarcity, which appears as a factor with medium-high centrality (1.45). The factors that increased their sense of material poverty were the variability of their income and the rising costs of living. Workers explained that salary fluctuations occur in part because they are paid per unit (e.g. per box packed, per bunch collected, per meter of soil dug out) instead of having an hourly wage. Thus, changes in market demand, the actual growth cycle of bananas, and the workers' own ability to perform physically demanding tasks result in corresponding changes in salary. In general, complaints about salary were commonplace among workers. However, these complaints often gave the impression that the workers felt under-compensated for the work that they performed. Some workers defined the relationships with their employee as exploitative and denounced a variety of questionable or illegal behaviour by companies that went from turning a blind eye on the hire of undocumented workers to sexual harassment to frequent violations of occupational health

regulations (e.g. keeping workers in the fields while a sector of the plantation is being sprayed aerially).

Health had high centrality among residents in Matina (1.90). However, residents referred primarily to the health risks that they faced, all of which are related directly or indirectly to the presence of banana plantations. The one exception was their concern about dengue and other mosquito-borne diseases, which are endemic to the region. Among the health impacts mentioned by residents of Matina, "exposure to agrochemicals" had the highest centrality (1.28). The preoccupation about pesticides in Matina is not surprising given the reliance of monocrop agriculture on agrochemicals and the fact that Costa Rica has the highest intensity in pesticide use in the world (Galt, 2008). As well, there is ample evidence of the negative health impacts of banana agriculture in surrounding populations (Wesseling et al., 2001). Yet, while the exposure to agrochemicals has higher centrality among the groups of workers, it is not uniquely an occupational concern as housewives also reported instances where the drift from the aerial spraying had stained hanging laundry or expressed fear that children might be affected when they are outside (see for instance Mora et al., 2014; van Wendel de Joode et al., 2014). Other health concerns voiced in Matina were fatigue from physical work, work accidents, and emotional stress. Fatigue is so prevalent among plantation workers that many use injections of vitamin B complexes to stay in shape. The causes of emotional stress varied, some interviewees talked about feeling stressed due to their economic situation and their responsibility as breadwinners, others talked about feeling frustrated with labour practices or with their circumstances more generally.

The only environmental factor that residents in Matina alluded to with regards to their well-being was the impact of flooding on their homes. As mentioned earlier, plantations are

situated in the floodplains, which is advantageous for banana agriculture but risky for human settlements, especially in areas such as Matina where there are informal settlements with poor construction. The severity of the floods varies from year to year but it is a recurrent disturbance and, at times, residents incur significant material losses. In addition, residents were concerned about waterborne diseases that are brought about with the flood waters. Some residents linked the floods to the degree of landscape change, especially river channelling, that banana companies have carried out over decades.

Human well-being in agricultural communities in the Bribri Indigenous Territory. The FCMs for Amubrë and for Suretka-Shiroles have the same basic structure with slightly different emphasis on certain elements, which can be explained, at least partially, by the spread of conventional agriculture. The factors with highest centrality in Amubrë are: economic need (2.8), environmental degradation (2.3), health (2.0), traditional values (1.8) and the presence of crime (1.6). In Suretka-Shiroles the factors with the highest centrality are: health (2.4), economic need (2.3), environmental degradation (2.1), the presence of drug traffic (1.6) and intensive agriculture (1.6). Given that the two FCMs are very similar, I describe them together pointing out the details where they diverge.

Beginning with material wealth, the main factor that stands out is how residents in both Indigenous sites defined their experience of material well-being in terms of what they lacked. Economic need was a factor with high centrality in both sites, although more pronounced in Amubrë (2.8) than in Suretka-Shiroles (2.3). When examining the demographic categories, material scarcity had the highest centrality in the FCMs of women, especially those from Amubrë (3.4), and lowest centrality in the FCMs of males from Suretka-Shiroles (1.8). According to producers, the main driver leading to material poverty was the low price obtained

from the sale of plantains (+0.6 in Amubrë and +0.4 in Suretka-Shiroles). A female producer from Amubrë explained: (T025) *"just think that a bag of rice costs 1,250 colones, and I sell a kilo of banana for 50 colones. So, I have to what… sell like 20 kilos of banana to buy a bag of rice. And that's just a bag of rice, there are other things."* Pricing is a long-standing, contentious issue among plantain Bribri producers. Producers sell their crop to middlemen from outside of the territory who in turn transport the fruit to a central depot in San Jose for distribution to national retailers. Aside from colluding on the price, middlemen also purchase plantains from traditional agriculture at one half of the price of plantains from conventional agriculture citing aesthetic appeal, given that the peel of traditional plantain is slightly darker and has more black spots. This explains why producers in Amubrë, who predominantly practice traditional agriculture, feel material poverty more acutely. Alternatively, traditional farmers also sell through organic farmer cooperatives that offer a better price than middlemen but this requires undergoing a process of certification.

Another driver of material need were floods (+0.4 in both sites), which impact the residents' farms, typically situated on the banks and on islands of the river to take advantage of the nutrients deposited by the floods. Thus, strong floods and avulsions can have disastrous impacts on the livelihoods of farmers. Other factors with lower centrality that also contributed to the economic scarcity felt by Bribri farmers were the increasing cost of living and small-scale theft of plantains (supposedly by people in the community). Farmers in both sites thought that securing wage labour would reduce their material poverty, yet they recognized that job opportunities in the territory were limited.

While material poverty was very common among farmers, Bribri residents in both sites also pointed to self-sufficiency as contributing to offset their needs. One interviewee explained (T021):

> *"One cannot complain because here one has everything. Here, it is not like one is going to go hungry or anything like that, I don't think… If someone goes hungry is because they want to… Here, thanks to God, we have bananas, plantains, fruits… well, lots of things that are edible that are produced here in the mountains, cassava, yam… lots of things here that the earth produces…"*

Yet, some producers indicated that the declining size of family plots compromises their ability to practice self-sufficiency. The population of Talamanca has more than quintupled in the past 40 years, rising from 2,790 inhabitants in 1973 to 30,712 inhabitants in 2011 (INEC, 2012). Most of the population has settled in the lower part of the territory, around the communities of Suretka-Shiroles (Yepez, 1999), which means that family plots in these areas are decreasing in size.

Health had high centrality in the two sites of the Bribri Indigenous Territory. The factors that had a positive influence on health had a connection with Indigenous identity. For instance, following a traditional diet - based on household vegetables and animals - was seen as having a positive influence on health. However, this factor had higher centrality in Amubrë (1.1) than in Suretka-Shiroles (0.7), probably reflecting the degree to which the two sites are influenced by the changing lifestyle and the shrinking size of family plots aforementioned. Residents linked the abandonment of the traditional diet to the emergence of "new diseases", that is, non-communicable diseases such as cardiovascular diseases, diabetes or cancer.

Residents in both sites also mentioned traditional medicine as a positive influence on their health but this factor had low centrality.

The factor that had the most negative impact on health was "exposure to agrochemicals", which had higher centrality in Suretka-Shiroles (0.9) than in Amubrë (0.5), corresponding to the spread of conventional agriculture in the territory. While the concern over pesticides might seem surprising in an area dedicated to smallholding agriculture, it is important to realize that Bribri producers follow the demands imposed by the middlemen. As well, Bribri farmers pointed out that they often lacked reliable sources of information about pesticide use and dosage. Information in this regard might come from those farmers who have previous experience in the large plantations in the lowlands or from the middlemen who impose somewhat arbitrary standards for pesticide use. For instance, the use of the chlorpyrifos-coated bag that middlemen insist on, has as much to do with making the plantain peel look good, as with protecting the fruit from insects. Emotional stress is another negative impact identified by Bribri residents, although it has low centrality.

In the Bribri Indigenous Territory, residents made a link between environment and health. The relationship was usually expressed as a concern that the declining environmental quality was impacting their health negatively. Environmental degradation had high centrality in both Amubrë (2.3) and Suretka-Shiroles (2.1) and residents were especially concerned about the contamination of waterways given that some rely directly on rivers and creeks for drinking water, fishing or washing. The drivers of environmental degradation were formulated in similar terms in both sites and were related mainly to the spread of intensive agriculture, which is a factor with medium-high centrality, Amubrë (1.4) and Suretka-Shiroles (1.6). When probed, farmers gave a variety of reasons why intensive agriculture is expanding in the

territory. A key driver is the presence of middlemen (+0.6 in Suretka-Shiroles and +0.4 in Amubrë) since they control the sale price and the requirements. While Indigenous farmers, particularly those in Amubrë, considered the relationship with the middlemen as unequal and exploitative, the fact remains that farmers are dependent on middlemen to commercialize their crops. Furthermore, Bribri farmers recognized that the lack of coordination among producers and the suspicion with which many view their local government creates the space where middlemen can step in to organize the commercialization of plantains. Other drivers of environmental degradation with lower centralities included the rising population that put pressure on infrastructure and increased the pollution of the waterways. As well, a looming environmental threat on the Bribri Indigenous Territory is the demand from outside for the territory's natural resources including the demand for exotic hardwoods, minerals and oil.

The same narrative around safety and crime from Matina can be heard in the Bribri Indigenous Territory. Residents feared petty crime committed by youth and linked it to the drug traffic. By contrast, Bribri residents blamed outside influences as driving the drug traffic (+0.5 in Amubrë and +0.6 in Suretka-Shiroles). Hence, Bribri residents found that holding on to their traditional values gave them a sense of security, as they associated these values with imparting a sense of respect for others. As well, they felt that knowing people in their community helped them to feel safer. In Suretka-Shiroles people also mentioned having a system of neighbourhood watch where people keep an eye on each other's houses. Last, in terms of having good social relations, residents of the Bribri Indigenous Territory mentioned getting involved in community projects, simply knowing people in the community, and behaving well towards others, in the sense of being respectful, having a good disposition and offering to help. Importantly, fostering "traditional values" is a factor with high centrality in

Amubrë (1.8) and medium in Suretka-Shiroles (1.3). Traditional values are a cross-cutting theme tied to environmental concerns, safety and social relations.

Discussion

The FCMs above describe the factors and relations that shape human well-being in three rural communities whose livelihoods are tied to the supply of agricultural provisioning services within the regions with the lowest human development index in Costa Rica (PNUD, 2011). The FCMs and the accompanying narratives offer a window to better understand what poverty means in each site, what residents care about and what they feel that they are lacking. As well, they make it possible to begin to elucidate the links between each community's experience of well-being and the form of resource management that is practiced.

Health

Health appeared as a factor with high centrality in all three regions. There are at least two points of connection where one can observe the influence of resource management on health. The first and most obvious link is the one that exists between health and intensification. Intensification means the introduction of agrochemicals to make up for the loss of regulating ecosystem services, such as the ability to stave off pests and the loss of nutrients in the soil. Hence, there is a direct impact on people's health from being exposed to fertilizers and pesticides. Indeed, the data shows that a concern about agrochemicals was a factor affecting health in all sites, and that it varied according to the degree to which agriculture had intensified, hence it was highest in Matina and lowest in Amubrë. As well, the concern over pesticides needs to be situated within the historical

legacy of the Caribbean coast of Costa Rica. Notorious cases such as the exposure of hundreds of banana plantation workers to the highly toxic nematicide dibromochloropropane (DBCP) that resulted in widespread sterility among males in the 1980s (Thrupp, 1991; Wesseling et al. 1996; Galt, 2008; Barraza et al., 2013), resonate in the collective memory of workers, a portion of whom are still fighting for compensation.

A second link between health and the form of environmental management relates to the establishment of command-and-control agriculture in monocrop plantations. Monocrop plantations produce high yields of provisioning services at the expense of regulating ecosystem services that need to be substituted or complemented by human-made processes. Yet, because the human-made substitutes are far from the natural function, land managers need to continuously ramp up the amount of intervention to maintain the desired levels of production (Holling & Meffee, 1996; Rist et al., 2014). Compounded by standardized commercial specifications, international sale contracts, and global competition from other tropical nations, it is not surprising that banana plantations require workers to perform menial tasks as quickly as possible. Thus, the amount of labour that is required under command-and-control agriculture can result in negative health impacts. In particular, the impact of accidents and fatigue on the health of workers in Matina are an indication of the degree of intervention that is necessary to produce bananas under this system of agriculture. By comparison, interviewees from the Bribri Indigenous Territory conceded that farming was hard but none of them alluded to fatigue as a factor impacting their health.

In the Bribri Indigenous Territory there was a third connection between the form of resource management and health, which had to do with the ability to maintain a traditional

diet. Bribri residents associated the emergence of non-communicable diseases, such as diabetes or heart disease, with the change in diet and lifestyle. This is tied in a very material sense to the switch to conventional agriculture where farmers have to give up space to grow cash crops, as opposed to traditional plots where farmers can cultivate cash crops alongside household vegetables. In addition, the exponential population growth that the territory has experienced in recent decades puts an added pressure on land resources that results in smaller family plots.

Social Relations

Social relations were constructed differently in the two regions. While there are social dimensions that may account for these differences, such as indigeneity or gender, the following relates directly to the system of agricultural production. First, the way in which residents of Matina had limited social relations was often tied to the lack of time due to the long workday. This is yet another impact that follows from the push to increase the yield of provisioning ecosystem services through the adoption of command-and-control agriculture. Second, the insistence on "keeping to oneself" as a way of relating to others is hard to interpret. Writing about the Costa Rican character in general, others have said that Costa Ricans tend to be cordial yet reserved in their social dealings (Biesanz et al., 1999). In the Bribri Indigenous Territory there was a similar tendency to stay away from people's affairs, although it was often stated in terms of "being respectful" rather than distant. It might very well be that residents in Matina simply value their privacy, however, the plantation system certainly reinforces a degree of isolation. One of the reasons is that in banana plantation workers are replaceable, especially in the absence of labour unions. This means that communities around the plantations have a number of people whose status is temporary, which might be less conducive of creating strong social bonds. In addition,

knowing that one is replaceable puts workers in a competitive rather than cooperative relationship with one another, which can lead to atomization. Some workers keep a low profile as a strategy to avoid being associated with the wrong crowd or being perceived as an agitator.

Having replaceable workers is the outcome of a system of production where the majority of jobs involve performing well-defined tasks requiring only basic skills and no previous agricultural knowledge. This was not always the case; according to Marquardt (2001), in the early days of the UFCO the company was heavily dependent on the ecological knowledge of Jamaican workers who could tell when to pick the fruit or how much pruning was necessary. This changed as the company introduced agronomists and engineers to replace ecological knowledge with scientific knowledge. At this point, the process of cultivating bananas was split into small tasks that demanded little or no judgement from the workers. Interestingly, this also meant that workers of Spanish descent replaced workers of Jamaican descent. This is one of the ways in which the optimization of a provisioning service results in a trade-off of a cultural service –knowledge and opportunities for education (MEA, 2003)—with broader impacts on human well-being.

In the Bribri Indigenous Territory the way that resource management impacted social relations was described in different terms, although not appreciably different between the two Indigenous communities. What transpires from the interviews is that certain rituals around farming build reciprocity among Bribri producers. For instance, farmers practice *manivuelta* (literally "returning a hand") where farmers help one another for completing tasks instead of hiring a day labourer. As well, for larger jobs, people may organize *chichadas,* a day of community work after which everyone is invited to share *chicha*

(an alcoholic beverage made out of fermented corn). These practices are common to both systems of agriculture in the Bribri Indigenous Territory. However, farmers also mentioned that these rituals are becoming less common as the integration into the market economy progresses and people expect to work for pay.

Economic Wealth

Given that provisioning ecosystem services become the commodities to be traded, it can be expected that a system that specializes in the single-minded pursuit of agricultural commodities such as a plantation would generate higher revenues. From the indications volunteered by plantation workers about their income, a field worker in 2011 could earn between 260,000 and 300,000 colones/month ($420 USD - $540 USD/month), although the salary can be substantially less if hired through a subcontractor. For comparison, the rural minimum wage at the time of the interviews was 198,681 colones/month (~ $360 USD/month) and the cost of the basic food basket in rural areas was around 35,000 colones (~$63 USD) per person per month (INEC, 2011). While it would be a stretch to describe the populations around the plantations as wealthy, large agribusinesses provide the bulk of the jobs in Matina. Still, complaints about salary were all too common and many denounced their labour conditions as precarious or exploitative.

The situation in Matina contrasts with the Bribri Indigenous Territory where economic scarcity emerged as a central variable defining material well-being, particularly in Amubrë. While agroforestry does not maximize the yield of provisioning services, in the case of the Bribri producers, it is crucial to understand that the commercialization of plantains has the largest impact on the material gains of famers. Given that middlemen are able to maintain an oligopsony (many sellers, few buyers), they are able to unilaterally fix the sale price and impose other, somewhat arbitrary, commercial requirements, such as the use chlorpyrifos-

coated bags. Middlemen purchase plantains grown using traditional agriculture (without the chlorpyrifos-coated bag) but only at half of the price of plantains grown using conventional agriculture. This helps to explain why farmers in Amubrë who practice predominantly traditional agriculture are economically worse off than farmers in Suretka-Shiroles who practice predominantly conventional agriculture. Thus, when considering the impact of agriculture on the livelihoods of remote producers, it is important to consider the system of distribution and access to the markets as part of the system of agricultural production.

Safety

Safety had very high centrality in Matina and medium centrality in the Bribri Indigenous Territory. However, there is a need to consider these findings within a larger narrative of perceived insecurity that is pervasive throughout the country. Put simply, the average Costa Rican tends to have a higher sense of insecurity than crime statistics seem to warrant. Indeed, a report found that Costa Ricans consistently overestimated their chances of being the victim of crime compared to the actual statistical probability. For instance, Costa Ricans thought themselves ten times more likely to be the victims of assault than the actual chances of being assaulted, or twice as likely to have a break-and-enter than the actual chances of the event happening (PNUD, 2005). Having said that, some details suggest that safety issues are more prevalent around Matina than in either community of the Bribri Indigenous Territory. For instance, only in Matina did residents mention fearing crimes of more violent nature, such as shootings and homicides, in addition to petty crimes such as thefts. As well, some of the communities visited in Matina appeared fortified to a higher degree, e.g. convenience store counters with protective fences or the presence of guard dogs in the houses. The threat of violence is a product of many variables. Among the ones identified by residents of Matina

were the drug traffic and having unoccupied youth. Those two factors were also identified in the Bribri Indigenous Territory and, in addition, they linked the drug traffic with non-Indigenous influences and with material poverty. I discuss the potential links between insecurity and resource management in each site in turn.

The presence of drug traffic in Matina is a result of geopolitical factors that are outside of the scope of this assessment. Indeed, the Caribbean coast of Costa Rica is a known stopover for cocaine coming from South America and an entry point for marihuana coming from Jamaica, especially in the vicinity of the port of that is approximately 35 km away (UNODC, 2013). Clearly, banana plantations do not produce the drug trade and the ensuing violence (although see Gaskins, 2008) but certain aspects on the way that monocultures are organized may favour the incidence of this form of criminality. Some of the factors that have been mentioned before, such as precarious labour conditions or the long work hours, contribute to youth being left unsupervised. In addition, the interviews made it evident that many residents felt dissatisfied with their lives, so there is little sense of place or belonging, which can increase the feeling of disenfranchisement. For example, a 22-year-old Costa Rican plantation worker explained: *"Whoever says that he feels happy working in a plantation is crazy. […] If someone gave you the choice between doing anything else and this, it's better to do anything else"* (M005). Similar sentiments were reflected when residents spoke of the hopes that they harboured for their children. Residents in Matina often framed their lifestyle as a sacrifice for their children (or their families) and wished a different life for their children. These types of disclosures contrast with the way in which Indigenous farmers lamented the change in lifestyle away from farming and how they wished that they could teach their children to farm. Back to the plantations, unsupervised youth with unclear or uninspiring life prospects have increased odds of

ending up involved with petty crime and the criminal activity that accompanies the drug trade.

On the other hand, petty crime is also a growing concern in the Bribri Indigenous Territory. Bribri residents mentioned an almost identical narrative about drugs and unsupervised youth as residents in Matina, and indeed, the county of Talamanca where the Bribri Territory is situated is the largest producer of marihuana at the national scale (UNODC, 2013). Yet, residents in the Bribri Indigenous Territory showed lower concern about criminality than those in Matina. In addition, Bribri residents also tied criminality to other factors: First, residents felt that the drug traffic was tied to the spread of non-Indigenous ideas and appealed to their traditional values as a way of regaining a feeling of safety. The claim is that being attuned with their traditional values provides the moral rectitude to prevent one from engaging in illicit activities. Thus, inasmuch as the spread of conventional agriculture erodes traditional values, it is viewed with some suspicion. However, there were no appreciable differences between the narratives of residents from Suretka-Shiroles and Amubrë on this point. The second factor that residents linked to criminal activity was material poverty, which is clearly a problem in the territory, particularly among those who practice traditional agriculture, as described above.

Finally, it was surprising that residents referred very little to their natural surroundings to describe their well-being. For instance, the only ecosystem service (or lack thereof) to which residents in Matina alluded directly was flooding. Yet, the lack of influence from natural factors on how residents of agricultural communities understand their well-being is telling in itself. Especially when considering that participants spoke at length about how the *system* of ecosystem service production impacted their well-being,

e.g. how their salary provides for their material needs or how the long workday reduces the time that they have for socializing. This is indicative of the fact that, while these communities are rural and are engaged in the production of agricultural provisioning services such as bananas or plantains, the benefits that residents derive from their ecosystems are mediated by an economic transaction (sensu Reyers et al., *submitted*). Indeed, the fruit produced in these communities is, for the most part, consumed in distant regions either nationally or internationally. Hence, at the micro-level and from the perspective of human well-being, it makes sense to consider the influence of ecosystem services along with their system of production and commercialization.

Conclusion

This analysis shows how different forms of natural resource management shape the conditions for human well-being in agricultural communities. Communities where the agricultural management system has increased its capacity to supply provisioning ecosystem services are economically better off but the accompanying loss of regulating ecosystem services gives rise to ecological problems that affect human health, and the loss of cultural ecosystem services has negative impacts on the social fabric of the communities affecting their sense of safety and their social relationships. On the other hand, communities where the system of agricultural management maintains a wider range of ecosystem services have a stronger sense of community and less negative impacts on their health but suffer from material scarcity. These conclusions are important to consider in light of the findings of the MEA (2005) that noted that the majority of ecosystem services were in decline with the exception of provisioning services, suggesting a trend towards the specialization in the production of ecosystem services that yield tradable commodities. It

is important to highlight that under the command-and-control management style that emerges as a result of the drive to optimize provisioning ecosystem services, efforts to maintain or restore regulating ecosystem services are restricted to the productive areas themselves. That is, in Matina land managers have no incentive to maintain regulating ecosystem services beyond what benefits the production of bananas. For example, plantations have modified the hydrology of the area in significant ways, such as draining swamps, building levees and channelizing rivers to ensure an adequate supply of water and well-drained soils (Marquardt, 2001). Yet, outside of the perimeter of the plantations, the population is left to deal with recurrent floods that impact their livelihoods and whose severity has been made worse by the scale of the disruption that the landscape has undergone. At the same time, it is relatively easy to externalize negative impacts or to have negative spillover effects with command-and-control agriculture. The aforementioned exposure of the population to agrochemical spray is a spillover effect of the need to boost the plantation ecosystem's ability to stave off pests. Hence, these are examples of how the single focus of command-and-control agriculture on boosting provisioning services establishes a system of incentives that rationalizes the externalization of impacts and the separation of benefits.

With respect to poverty alleviation, there is a dearth of empirical studies exploring the way in which ecosystem services and poverty interact. A recent review of this literature notes the following gaps: First, that studies fail to establish causal links between poverty and ecosystem degradation; second, that the focus is on the contribution of a single ecosystem service instead of bundles of ecosystem services; third, that regulating ecosystem services remain understudied; and fourth, that although studies use multidimensional definitions of poverty they continue to emphasize income-generating

activities and assets (Suich et al., 2015). This article begins to address some of the shortcomings identified. In particular, the use of fuzzy cognitive maps provides a powerful and versatile tool to explore linkages among multiple dimensions of human well-being and provisioning, regulating and cultural ecosystem services.

However, FCMs have important limitations that need to be considered carefully. Constructing the FCMs from semi-structured interviews and qualitative data analysis is a labour intensive process that limits the likelihood of using FCMs for larger-scale assessments. Yet, there are opportunities to streamline the methodology. For instance, it may be more effective to begin with key informant interviews to identify the main factors affecting well-being in a region. After these have been established, the connections among the factors and their weights can be discussed in a focus group setting with the different demographic groups relevant to that region. The group may choose to add factors that the key informants missed but the emphasis would be on determining the relationship among the factors already identified. This would certainly shorten the time that it takes to produce the augmented matrixes and, if the focus groups were facilitated properly, it would not compromise the quality of the data. Furthermore, proceeding in this way may improve the quality of the insights derived from the FCMs because it would reduce the tendency of respondents to produce a list of factors that relate back to the particular dimensions of well-being about which they were asked. This is a common drawback of the interview process used (Bachhoffer, personal communication). Instead, the focus group may be able to draw connections among the factors, thus increasing the chances of identifying feedbacks and indirect relations. Finally, if the FCMs can be constructed relatively quickly, it would be possible to reproduce the relations identified in a simulation model to explore alternative policy outcomes. This would greatly improve their ability to

inform decision-making at the local scale.

Chapter

6. CONCLUSION

The goal of this dissertation was to offer a better understanding of the interplay between ecosystem services, human well-being and environmental management in resource-dependent communities. In the first chapter I referred to three ongoing debates in the field of ecosystem services that were of interest to my inquiry: First, theoretical debates around the advantages and disadvantages of different conceptualizations of ecosystem services; second, the need for clarity on the relationship between ecosystem services and poverty alleviation; third, the impacts of trade-offs of ecosystem services on human well-being. All of these debates continue to evolve, both in the way that I think about them and within the academic literature, however, I would like to draw attention to the following contributions that emerge from this dissertation:

On the matter of alternative conceptualizations of ecosystem services to the one proposed by the MEA (2003), particularly with regards to conceptualizations that further disaggregate the intermediate steps from natural functions to improvements in human well-being, this dissertation proposes the conceptual model shown in Figure that is more in line with the 'cascades' of ecosystem services suggested by de Groot et al., (2010), Potschin & Haines-Young (2011) or TEEB (2010). What is important to note about all of these conceptualizations, including the one from the MEA (2003), is that they are complementary rather than opposing as they serve slightly different purposes. The MEA works best for larger scale assessments for the purposes of quantification of ecosystem services and to reach out to policy makers. In this sense, the MEA has been very successful. The gaps that other models fill

are conceived for different purposes, scales and audiences. The model that I proposed is intended to guide resource management at local or regional scales. It is also a model that is more conceptual than practical, as it would be difficult or impossible to measure all of the different benefits derived from one ecosystem service for all of the possible ecosystem users. Instead, the model draws attention to questions of distribution and access and emphasizes local-level perceptions. In many ways, this conceptualization guided how I thought about the rest of the dissertation.

The framework for thinking about power and access that is contained in the second manuscript provides an additional layer to the models used to conceptualize ecosystem services. Again, the level of detail that is required to portray power relations in the production of ecosystem services and the distribution of benefits renders the exercise difficult at large scales. However, the idea that there are gatekeepers is applicable to the understand the transformation from ecosystem services to benefits in general. It also has the potential to complement commodity supply chain analyses such as those carried out by Ribot (1998) on charcoal in Senegal and within the Costa Rican context by Diaz-Porras (2009). Finally, while the article emphasizes the roles of gatekeepers and how they are able to establish dominance, it also shows that through the careful analysis of power relations is possible to discern what would be useful interventions to challenge patterns of dominance that reinforce poverty and inequality. At a conceptual level, the second article is the beginning of a conversation about resilience thinking and power relations, a topic that has been signalled as urgent by many (e.g. Cote and Nightingale, 2011; Brown, 2014).

With respect to clarifying the links between ecosystem services and human well-being in the context of poverty alleviation, the first and third manuscript arrive at similar conclusions

even though the first one focuses on local-level perceptions of what aspects of nature constitute ecosystem services for local populations, and the third one considers community-level perceptions of human well-being. In both cases, the pattern that emerges is that provisioning ecosystem services are more closely related to material aspects of well-being; regulating services affect primarily health; and cultural ecosystem services affect social relations, including safety. While these links are consistent with other micro-level assessments (e.g. Sandhu & Sandhu, 2014; de Oliveira & Berkes, 2014) there is a need to probe these relations further. In particular, it would be important for future work to quantify how changes in the supply of different ecosystem services interact with specific dimensions of human well-being. For instance, does human well-being (or a given dimension of human well-being) increase in a linear manner with the supply of ecosystem services? Does it reach a plateau? Are there bifurcations in the relationship between ecosystem services and human well-being? This work would be useful to guide the management of landscapes at the regional scale.

In addition, in the context of ecosystem services and poverty alleviation it might be important to distinguish between poverty and vulnerability more clearly. Poverty is usually defined as a lack or a shortage measured against a minimum standard, e.g. households are considered poor when their income falls below a poverty line. In this sense, poverty has an absolute quality, although clearly there are different standards that can be used and poverty lines themselves vary over time and between countries. Vulnerability is a more relative measure of well-being because it is a function of exposure to a risk, e.g. drought, and coping capacity, e.g. savings or social capital (Gaiha & Imai, 2004; Guimaraes, 2007). Thus ,vulnerability is most evident in the aftermath of a shock. Poverty and vulnerability interact but non-poor populations might also be vulnerable, e.g. households in the Florida coast of the United States can have incomes much higher than the poverty line but they remain vulnerable

to periodic hurricanes. Some of the research in this dissertation suggests that poverty may be closer correlated to the supply of provisioning ecosystem services, that are usually tradable, whereas vulnerability may be more closely correlated with the maintenance of regulating ecosystem services. Thus, communities with sharp trade-offs between provisioning and regulating services may be less poor in an economic sense but highly vulnerable to environmental disruption and to shocks in the long term.

At the same time, the analyses made evident that some dimensions of human well-being are more dependent on ecosystems than others. For instance, the sense of safety has some connections with ecosystem services (I point these out in chapter 5) but it is most directly tied to larger social and governance processes. Hence, it is important to remain cautious about the explanatory power of ecosystem services to interpret all aspects of human well-being. This is an interesting insight, especially given that the communities in this research were all rural, resource-dependent communities. Hence, what seems to emerge is that the framework of ecosystem services as currently conceived is most applicable to societies that rely very directly on ecosystems, such as those that practice self-subsistence. But this is a small fraction of the human population and increasingly we live in an urbanized world. Hence, there is an open question about the usefulness of the framework of ecosystem services to explain the well-being of urban populations (e.g. what is soil erosion to a streetcar driver?) and perhaps this realization makes the call for humans to reconnect with the biosphere (Folke et al., 2011) all the more relevant.

An interesting distinction in this regard has been advanced by Reyers et al (submitted) who proposed to divide ecosystem services between those that are directly connected to the well-being of a group of people and those that are mediated by an economic transaction. Hence,

a fishing village where people rely on their catch as a source of protein in their diet would fall under the first category, and a fishing village where people sell their catch as a source of income would fall under the second category. While simple, this distinction starts to draw attention to the intermediate processes that are necessary to produce ecosystem benefits from natural ecosystems. Therefore, it offers an opportunity to consider in more detail aspects related to the system of production and commercialization of ecosystem services. Others have drawn attention to fact that ecosystem services are co-produced and that considerations of human labour are altogether absent from the way that ecosystem services are conceived (Peterson et al., 2010; Gomez-Baggethun & Ruiz-Perez, 2011). Furthermore, there is still a paucity of studies linking ecosystem services with resource management and human well-being (an exception is Andersson et al., 2015).

This dissertation approached the study of the relationship between ecosystem services and human well-being using unconventional methods that drew heavily on participatory action research and that were geared towards qualitative and semi-quantitative inquiry. This choice contrasts with more traditional assessments of ecosystem services conducted from a quantitative perspective emphasizing the ecological or economic dimensions. Part of the motivation behind the choices of methodology was that I was primarily interested in the insights from the producers of ecosystem services and that others have already done assessments of ecosystem services much better than I could. Thus, the methods that I used are meant as complementary to quantitative assessments and aimed to explore what ecosystem services are for non-disciplinary experts at the micro-scale. In a nutshell, what this dissertation has done is to consider more explicitly the processes that translate ecosystem services into ecosystem benefits at local scales. In part, this helps to offer a contrast to the narrative of sustainable development where there has been a lot of emphasis on increasing, maintaining or

restoring ecosystem services but relatively less importance has been focused on the distribution of services. However, all of the work in the dissertation has been conducted at the local-scale and scaling up these insights to inform resource management without becoming excessively complicated remains a challenge.

Future Directions

The questioning of the relationship between ecosystem services and human well-being has yielded important insights but also points to future research needs. I outline two gaps that would complement the work carried out so far: First, there is a need to better understand how social and ecological factors interact in decision making at the farm level. Responses to environmental and social changes in smallholding agriculture rest on decisions taken at the household level, that is, individual farmers deploy a range of land use and land management strategies based on their knowledge of the issue and their household circumstances. Each of these responses has the potential to set off a feedback loop that either reinforces or reduces the original stressor. Because of the complexity of social-ecological systems, the original stressor, the farmer's response and the effect resulting from the feedback loop might take place at different temporal and spatial scales, giving rise to surprises. For instance, anecdotal evidence from interviews with farmers suggests that increases in the price of their crop are followed by increases in the use of agrochemicals as farmers want to take advantage of the good price. Moreover, if the price of the crop stays high, farmers are likely to intensify their production by switching from agroforestry to monocrop. Thus, a policy to increase crop prices, which is usually considered desirable in terms of improving rural livelihoods, can result in higher health risks to agricultural communities and a myriad of negative ecosystem impacts.

By examining adaptive responses to changing price signals, it will be possible to assess not only the type of feedback mechanisms that are set off, but also critical thresholds in farmer's behaviour. For instance, a farmer might not do anything different if the price of the crop increases 10%, but might begin applying additional agrochemicals if the price increases by 20%, and might turn to monocrop if the price increases by 40%. Among the adaptation responses, changes in land use (e.g. from plantain to fallow), and in land management (e.g. from plots of mixed crops to single-crop plots) are especially important because they might become drivers of larger ecosystem change. In addition, given that a farmer's social and economic situation plays a key role in determining the type of response and the threshold for action, factors such as access to credit, size of holding or opportunities for wage labour, could be used to contextualize adaptation strategies. Understanding farmers' decisions in terms of the dynamic interaction between socioeconomic and environmental factors will increase the ability of resource-dependent communities to cope with the inherent uncertainty of international crop pricing policies.

Second, there is a need to better identify trade-offs between ecosystem services and different dimensions of well-being. In the third article I *assumed* that monocrop plantations involved steep trade-offs between provisioning and regulating ecosystem services and that agro-forestry agriculture maintained a range of ecosystem services. The assumption is supported by others, e.g. Foley et al., 2005; Rodriguez et al., 2006; Andersson et al., 2005, yet it remains unquantified. An important contribution to the field of ecosystem services would be to spatially map together indicators of provisioning ecosystem services (e.g. yields), regulating or cultural ecosystem services (e.g. eco-tourism, pollination) and human well-being (e.g. health indicators, criminality indexes) to identify bundles of ecosystem services together with bundles of human well-being. Hamann (2014) has started to do this work in South Africa and I believe

that Costa Rica has enough spatial and sociological data to do it as well. By mapping provisioning services, regulating services and human well-being together, it would be possible to identify places that have sharp trade-offs in ecosystem services where well-being is either high or low, and places that have low trade-offs in ecosystem services where well-being is either high or low. These places could become important case studies to understand the impact of governance and management on livelihoods.

BIBLIOGRAPHY

Abel, N., Cumming, D. H., & Anderies, J. M. (2006). Collapse and reorganization in social-ecological systems: Questions, some ideas, and policy implications. *Ecology and Society, 11*(1), 17.

Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography, 24*(3), 347-364.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change, 16*(3), 268-281.

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockstrom, J. (2005). Social-ecological resilience to coastal disasters. *Science, 309*(5737), 1036-1039.

Alkire, S. (2002). Dimensions of human development. *World Development, 30*(2), 181-205.

Allison, H. E., & Hobbs, R. J. (2004). Resilience, adaptive capacity, and the lock-in trap of the western Australian agricultural region. *Ecology and Society, 9*(1).

Andersson, E., Nykvist, B., Malinga, R., Jaramillo, F., & Lindborg, R. (2015). A social–ecological analysis of ecosystem services in two different farming systems. *AMBIO: A Journal of the Human Environment, 44*(1 Supplement), 102-112.

Aravena, J. (2005). *La expansion piñera en Costa Rica: La realidad de los perdedores de la agroindustria exportadora de la piña* . Costa Rica: La Asociación Comunidades Ecologistas la Ceiba.

Armitage, D. (2007). Governance and the commons in a multi-level world. *International Journal of the Commons, 2*(1), 7-32.

Armitage, D. R., & Plummer, R. (Eds.). (2010). *Adaptive capacity and environmental governance*. Berlin, Germany: Springer.

Armitage, D., Berkes, F., & Doubleday, N. (Eds.). (2007). *Adaptive co-management: Collaboration, learning and multi-level governance.* Vancouver, B.C., Canada: UBC Press.

Axelrod, R. (1976). *Structure of decision, the cognitive maps of political elites.* Princeton, New Jersey: Princeton University Press.

Bachrach, P., & Baratz, M. S. (1962). Two faces of power. *American Political Science Review, 56(4),* 947-952.

Balmford, A., & Bond, W. (2005). Trends in the state of nature and their implications for human well-being. *Ecology Letters, 8*(11), 1218-1234.

Barraza, D., Jansen, K., de Joode, B. V. W., & Wesseling, C. (2011). Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. *Environmental research*, *111*(5), 708-717.

Barraza, D., Jansen, K., van Wendel de Joode, B., & Wesseling, C. (2013). Social movements and risk perception: unions, churches, pesticides and bananas in Costa Rica. *International journal of occupational and environmental health*, *19*(1), 11-21.

Bennett, E. M., & Balvanera, P. (2007). The future of production systems in a globalized world. *Frontiers in Ecology and the Environment, 5*(4), 191-198.

Bennett, E. M., Peterson, G. D., & Gordon, L. J. (2009). Understanding relationships among multiple ecosystem services. *Ecology Letters, 12*(12), 1394-1404.

Berbés-Blázquez, M. (2012). A participatory assessment of ecosystem services and human well-being in rural Costa Rica using photo-voice. *Environmental Management, 49*(4), 862-875. doi:10.1007/s00267-012-9822-9

Berkes, F., Colding, J., & Folke, C. (Eds.). (2003). *Navigating social-ecological systems: Building resilience for complexity and change*. Cambridge, UK: Cambridge University Press.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience, 1*, 13-20.

Berkes, F., & Ross, H. (2013). Community resilience: Toward an integrated approach. *Society & Natural Resources, 26*(1), 5-20.

Bernstein, H. (2010). *Class dynamics of agrarian change.* Kumarian Press.

Biesanz, M. H., Biesanz, R., & Biesanz, K. Z. (1999). *The ticos: Culture and social change in Costa Rica*. London, UK: Lynne Rienner.

Bonatti, J., Borge, C., Herrera, B., & Paaby, P. (2005). Efectos ecológicos del cultivo de la piña en la cuenca media del río General-Térraba de Costa Rica. *Informe Técnico,* (4)

Bosak, K. (2008). Nature, conflict and biodiversity conservation in the Nanda Devi biosphere reserve. *Conservation and Society, 6(3),* 211.

Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? the need for standardized environmental accounting units. *Ecological Economics, 63*(2), 616-626.

Brauman KA, Daily GC, Duarte TK, Mooney HA (2007) The nature and value of ecosystem services: An overview of highlighting hydrologic services. *Annual Review of Environment and Resources 32:*67-98

Brown, K. (2014). Global environmental change I: A social turn for resilience? *Progress in Human Geography, 38*(1), 107-117.

Butler, C. D., & Oluoch-Kosura, W. (2006). Linking future ecosystem services and future human well-being. *Ecology and Society, 11*(1), 30.

Calvo-Alvarado, J., Arias, D., & Richter, D. (2007). Early growth performance of native and introduced fast growing tree species in wet to sub-humid climates of the southern region of Costa Rica. *Forest Ecology and Management, 242*(2), 227-235.

Carlson ED, Engebretson J, Chamberlain RM (2006) Photovoice as a social process of critical consciousness. *Qualitative Health Research 16(6*):836-852

Carlsson, B. (2001). Depicting experiences. *Scandinavian Journal of Educational Research, 45(2),* 125-143.

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems, 4*(8), 765-781.

Carpenter, S. R., Mooney, H. A., Agard, J., Capistrano, D., Defries, R. S., Diaz, S., et al. (2009). Science for managing ecosystem services: Beyond the millennium ecosystem assessment. *Proceedings of the National Academy of Sciences of the United States of America, 106*(5), 1305-1312.

Castleden H, Garvin T, Huu-ay-aht First Nation (2008) Modifying photovoice for community-based participatory Indigenous research. *Social Science & Medicine 66*:1393-1405

Castleden H, Garvin T, Huu-ay-aht First Nation (2009) "Hishuk Tsawak" (everything is one/connected): A Huu-ay-aht worldview for seeing forestry in British Columbia, Canada. *Society and Natural Resources 22:*789-804

Catalani, C., & Minkler, M. (2010). Photovoice: A review of the literature in health and public health. *Health Education & Behavior : The Official Publication of the Society for Public Health Education, 37(3),* 424-451.

Chan, K., Satterfield, T., & Goldstein, J. (2012). Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics, 74*, 8-18.

Chapin F., Peterson, G., Berkes, F., Callaghan, T., Angelstam, P., Apps, M., et al. (2004). Resilience and vulnerability of northern regions to social and environmental change. *AMBIO: A Journal of the Human Environment, 33*(6), 344-349.

Chapin, F. S., Kofinas, G. P., & Folke, C. (2009). *Principles of ecosystem stewardship* Springer.

Chapman M (2005) Once upon a time in Volcán, Costa Rica: Integrating values into watershed management and poverty alleviation. *Review of Policy Research 22(6):*859-880

Charmaz, K. (1983). The grounded theory method: An explication and interpretation. In R. M. Emerson (Ed.), *Contemporary field research* (pp. 109-126). Boston: Brown.

Charmaz, K. (2008). Grounded theory as an emergent method. In S. N. Hesse-Biber, & P. Leavy (Eds*.), Handbook of emergent methods* (pp. 155-170). New York, NY: Guilford Press.

Collier J (1967) *Visual anthropology: photography as a research method.* Holt, Rinehart and Winston, New York, 248 pp

Corporación Bananera Nacional, CORBANA. (2013). *Estadisticas bananeras.* Retrieved 12/07, 2014, from https://www.corbana.co.cr/categories/estadisticas-bananeras

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Thousand Oaks, California: Sage Publications.

Costanza, R., & Daly, H. E. (1992). Natural capital and sustainable development. *Conservation Biology, 6*(1), 37-46.

Costanza, R., d'Arge, R., Groot, R. d., Farber, S., Grasso, M., Hannon, B., et al. (1998). The value of the world's ecosystem services and natural capital. *Ecological Economics, 25*(1), 3-15.

Cote, M., & Nightingale, A. J. (2012). Resilience thinking meets social theory situating social change in socio-ecological systems research. *Progress in Human Geography, 36*(4), 475-489.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA, USA: Addison-Wesley.

Cummins, R. A. (1996). The domains of life satisfaction: An attempt to order chaos. *Social Indicators Research, 38*(3), 303-328.

Dahl, R. A. (2005). *Who governs? Democracy and power in an American city*. Yale University Press.

Dahlquist, R. M., Whelan, M., Winowiecki, L., Polidoro, B., Candela, S., Harvey, C. A., et al. (2007). Incorporating livelihoods in biodiversity conservation: A case study of cacao agroforestry systems in Talamanca, Costa Rica. *Biodiversity and Conservation, 16*(8), 2311-2333.

Daily, G. (1997). *Nature's services: Societal dependence on natural ecosystems* Island Press.

Dasgupta, S., Deichmann, U., Meisner, C., & Wheeler, D. (2005). Where is the poverty–environment nexus? Evidence from Cambodia, Lao PDR, and Vietnam. *World Development, 33*(4), 617-638.

Davidson, D. J. (2010). The applicability of the concept of resilience to social systems: Some sources of optimism and nagging doubts. *Society and Natural Resources, 23*(12), 1135-1149.

Daw, T., Brown, K., Rosendo, S., & Pomeroy, R. (2011). Applying the ecosystem services concept to poverty alleviation: The need to disaggregate human well-being. *Environmental Conservation, 38*(04), 370-379.

De Groot, R. S. (1987). Environmental functions as a unifying concept for ecology and economics. *Environmentalist, 7*(2), 105-109.

De Groot, R. S., Alkemade, R., Braat, L., Hein, L., & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity, 7*(3), 260-272.

De Groot, R. S., Wilson, M. A., & Boumans, R. M. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics, 41*(3), 393-408.

de Oliveira, Luiz Eduardo Chimello, & Berkes, F. (2014). What value São Pedro's procession? Ecosystem services from local people's perceptions. *Ecological Economics, 107*, 114-121.

DeClerck, F., Ingram, J. C., & Rumbaitis del Rio, Cristina M. (2006). The role of ecological theory and practice in poverty alleviation and environmental conservation. *Frontiers in Ecology and the Environment, 4*(10), 533-540.

Deneulin, S., & Shahani, L. (2009). *An introduction to the human development and capability approach: Freedom and agency* IDRC.

Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons. *Science, 302*(5652), 1907-1912.

Dixon, M., & Hadjialexiou, M. (2005). Photovoice: Promising practice in engaging young people who are homeless. *Youth Studies Australia, 24(2),* 52.

Duraiappah AK (1998) Poverty and environmental degradation: a review and analysis of the nexus. *World Development 26(12):*2169-2179

Enfors, E. I., & Gordon, L. J. (2008). Dealing with drought: The challenge of using water system technologies to break dryland poverty traps. *Global Environmental Change, 18*(4), 607-616.

England, R. W. (1998). Measurement of social well-being: Alternatives to gross domestic product. *Ecological Economics, 25*(1), 89-103.

Fabricius C, Folke C, Cundill G, Schultz L (2007) Powerless spectators, coping actors, and adaptive co-managers: a synthesis of the role of communities in ecosystem management. *Ecology and Society 12*(1): 2

Fisher, B., & Kerry Turner, R. (2008). Ecosystem services: Classification for valuation. *Biological Conservation, 141*(5), 1167-1169.

Fisher, B., Turner, R. K., & Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological Economics, 68*(3), 643-653.

Foley, J. A., Defries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., . . . Snyder, P. K. (2005). Global consequences of land use. *Science, 309*(5734), 570-574. doi:10.1126/science.1111772

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change, 16*(3), 253-267.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society, 15*(4), 20.

Folke C, Fabricius G, Cundill G, Schulz L (2005) Communities, ecosystems and livelihoods. In: Capistrano D, Samper C, Lee M, Raudsepp-Hearne C (ed), *Ecosystems and human well-being: multiscale assessments.* Island Press, Washington, DC, pp 261–277

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environmental Resources, 30*, 441-473.

Folke, C., Jansson, A., Rockström, J., Olsson, P., Carpenter, S. R., Chapin, S. I., . . . Westley, F. (2011). Reconnecting to the biosphere. *AMBIO: A Journal of the Human Environment, 40*, 719-738.

Food and Agriculture Organization. (2009). Glossary of organic agriculture. Retrieved 08/08, 2014, from http://www.fao.org/organicag/oag-glossary/en/

Foucault, M. (1980). *Power/knowledge: Selected interviews and other writings, 1972-1977.* Random House LLC.

Forsyth, T., Leach, M., & Scoones, T. (1998). *Poverty and environment: Priorities for research and study: An overview study, prepared for the United Nations development programme and European commission.* Institute of Development Studies.

Freire, P. (1996). *Pedagogy of the oppressed* (M. Bergman-Ramos Trans.). (3rd ed.). New York, NY: Continuum.

Fukuda-Parr, S. (2003). The human development paradigm: Operationalizing Sen's ideas on capabilities. *Feminist Economics, 9*(2-3), 301-317.

Gaiha, R., & Imai, K. (2004). Vulnerability, shocks and persistence of poverty: Estimates for semi-arid rural south India. *Oxford Development Studies, 32*(2), 261-281.

Gallopín, G. C., Funtowicz, S., O'Connor, M., & Ravetz, J. (2001). Science for the Twenty-First century: From social contract to the scientific core. *International Social Science Journal, 53*(168), 219-229.

Galt, R. E. (2008). Beyond the circle of poison: Significant shifts in the global pesticide complex, 1976–2008. *Global Environmental Change, 18*(4), 786-799.

García-Serrano, C. R., & Del Monte, J. P. (2004). The use of tropical forest (agroecosystems and wild plant harvesting) as a source of food in the Bribri and Cabecar cultures in the Caribbean coast of Costa Rica*. Economic Botany, 58(1),* 58-71.

Gaskins, K. C. (2008). Chiquita goes bananas: Counter-terrorism legislation threatens US multinationals. *North Carolina Journal of International Law and Commercial Regulation, 34*, 263.

Giordano, R. (2010). A fuzzy conflict measure for conflict dissolution in drought management. *2010 IEEE International Conference on Computational Intelligence for Measurement Systems and Applications (CIMSA),* pp. 60-65.

Gómez-Baggethun, E., De Groot, R., Lomas, P. L., & Montes, C. (2010). The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics*, *69*(6), 1209-1218.

Gómez-Baggethun, E., & Ruiz-Pérez, M. (2011). Economic valuation and the commodification of ecosystem services. *Progress in Physical Geography, 35*(5), 613-628.

Graziano, K. J. (2004). Oppression and resiliency in a post-apartheid South Africa: Unheard voices of black gay men and lesbians*. Cultural Diversity and Ethnic Minority Psychology, 10(3),* 302.

Gudynas, E. (2011). Buen vivir: Today's tomorrow. *Development*, *54*(4), 441-447.

Gudynas, E., & Acosta, A. (2011). La renovación de la crítica al desarrollo y el buen vivir como alternativa. *Utopía y Praxis Latinoamericana*, *16*(53), 71-83.

Guevara-Viquez, F. (2011). *Cronología básica de los pueblos indígenas de Costa Rica: Desde los inicios del siglo XVI hasta el año 2000*. San Jose, Costa Rica: Siwa Pako.

Guimaraes, R. J. R. (2007). Searching for the vulnerable: A review of the concepts and assessments of vulnerability related to poverty. *The European Journal of Development Research, 29*(2), 234-250.

Gunderson, L. (2010). Ecological and human community resilience in response to natural disasters. *Ecology and Society*, *15*(2), 18.

Gunderson, L. H., & Holling, C. S. (Eds.). (2001). *Panarchy: Understanding transformations in human and natural systems*. Washington, D.C., USA: Island Press.

Gunderson, L. H., Peterson, G. D., & Holling, C. S. (2008). Practicing adaptive management in complex social-ecological systems. In J. Norberg, & G. S. Cumming (Eds.), *Complexity theory for a sustainable future* (pp. 223-245). New York, NY, USA: Columbia University Press.

Gunderson, L. H., & Pritchard, L. (2002). *Resilience and the behavior of large-scale systems*. Washington, D.C., USA: Island Press.

Hamann, M. (2014). *Mapping social-ecological systems and human well-being: A spatial exploration of the links between people and the environment in South Africa.* Unpublished PhD, Stockholm Resilience Centre, Stockholm, Sweden.

Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual Studies, 17(1),* 13-26.

Harrington, R., Anton, C., Dawson, T. P., de Bello, F., Feld, C. K., Haslett, J. R., et al. (2010). Ecosystem services and biodiversity conservation: Concepts and a glossary. *Biodiversity and Conservation, 19*(10), 2773-2790.

Hein, L., Van Koppen, K., De Groot, R. S., & Van Ierland, E. C. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics, 57*(2), 209-228.

Hernandez, C.E., Witter, Scott G. (1996). Evaluating and managing the environmental impact of banana production in Costa Rica: A systems approach. *Ambio, 25*(3), 171-178.

Hicks, C., & Cinner, J. (2014). Social, institutional, and knowledge mechanisms mediate diverse ecosystem service benefits from coral reefs. *Proceedings of the National Academy of Sciences of the United States of America,*

Hicks, N., & Streeten, P. (1979). Indicators of development: The search for a basic needs yardstick. *World Development, 7*(6), 567-580.

Hilje-Quirós B (1993) *La colonización agrícola de Costa Rica (1840-1940).* Universidad Estatal a Distancia, San Jose, Costa Rica

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics,* 1-23.

Holling, C. S. (1978). Adaptive environmental assessment and management. *Adaptive Environmental Assessment and Management.,*

Holling, C. S. (1996). Engineering resilience versus ecological resilience. (pp. 31-44). Washington, D.C., USA: National Academy Press.

Holling, C., & Meffe, G. (1996). Command and control and the pathology of natural resource management. *Conservation Biology, 10*(2), 328-337. doi:10.1046/j.1523-1739.1996.10020328.x

Howe, C., Suich, H., van Gardingen, P., Rahman, A., & Mace, G. M. (2013). Elucidating the pathways between climate change, ecosystem services and poverty alleviation. *Current Opinion in Environmental Sustainability, 5*(1), 102-107.

Huitema, D., Mostert, E., Egas, W., Moellenkamp, S., Pahl-Wostl, C., & Yalcin, R. (2009). Adaptive water governance: Assessing the institutional prescriptions of adaptive co-management from a governance perspective and defining a research agenda. *Ecology and Society, 14*(1), 26.

Hurworth, R. (2004). Photo-interviewing. *Qualitative Research Journal,* 4(1), 73.

Hussey, W. (2006). Slivers of the journey: The use of photovoice and storytelling to examine female to male transsexuals' experience of health care access. *Journal of Homosexuality, 51(1),* 129-158.

Isaac, J. C. (1987). Beyond the three faces of power: A realist critique. *Polity*, 4-31.

Isaac, M. E., Dawoe, E., & Sieciechowicz, K. (2009). Assessing local knowledge use in agroforestry management with cognitive maps. *Environmental Management,* 43(6), 1321-1329.

Instituto Nacional de Estadística y Censos (INEC) (2009) *Cifras básicas sobre pobreza e ingresos.* San Jose, Costa Rica

Jurkowski, J. M., & Paul-Ward, A. (2007). Photovoice with vulnerable populations: Addressing disparities in health promotion among people with intellectual disabilities. *Health Promotion Practice,* 8(4), 358-365.

Kafetzis, A., McRoberts, N., & Mouratiadou, I. (2010). Using fuzzy cognitive maps to support the analysis of stakeholders' views of water resource use and water quality policy. In M. Glykas (Ed.), *Fuzzy cognitive maps* (pp. 383-402). Berlin, Germany: Springer-Verlag.

Kok, K. (2009). The potential of fuzzy cognitive maps for semi-quantitative scenario development, with an example from Brazil. *Global Environmental Change,* 19(1), 122-133.

Kosko, B. (1986). Fuzzy cognitive maps. *International journal of man-machine studies*,*24(1),* 65-75.

Kosko, B. (1988). Hidden patterns in combined and adaptive knowledge networks. *International Journal of Approximate Reasoning, 2(4),* 377-393.

Kremen, C. (2005). Managing ecosystem services: What do we need to know about their ecology? *Ecology Letters, 8*(5), 468-479.

Krishnaswamy J, Ritcher DD (2002) Properties of advanced weathering-stage soils in tropical forests and pastures. *Soil Science Society of America Journal 66:*244-253

Kumar, P. (Ed.). (2010). *The economics of ecosystems and biodiversity: Ecological and economic foundations* UNEP, Earthprint.

Lebel, L., Anderies, J. M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T. P., et al. (2006). Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society, 1*(19), 11.

Lee, K. N. (1994). *Compass and gyroscope: Integrating science and politics for the environment*. Washington, D.C., USA: Island Press.

Lukes, S. (1974). *Power: A radical view*. London Macmillan.

Marquardt, S. (2001). "Green havoc": Panama disease, environmental change, and labor process in the central american banana industry. *The American Historical Review, 106*(1), 49-80.

Max-Neef, M., Elizalde, A., & Hopenhayn, M. (1992). Development and human needs. *Real-Life Economics: Understanding Wealth Creation, Edited by: Ekins, P.and Max-Neef, M., Routledge, London*, 197-213.

Mason, J. (2009). *Qualitative researching (2nd ed.).* Thousand Oaks, California: SAGE Publications.

Maynard, S., James, D., & Davidson, A. (2010). The development of an ecosystem services framework for South East Queensland. *Environmental Management, 45*(5), 881-895.

McConnell, C. (2008). *Iniciativas de manejo en la subcuenca del río volcán, cuenca del río grande de térraba.* Unpublished M.Sc., Instituto Tecnológico de Costa Rica, Cartago, Costa Rica.

McIntyre, A. (2003). Through the eyes of women: Photovoice and participatory research as tools for reimagining place. *Gender, Place and Culture: A Journal of Feminist Geography,* 10(1), 47-66.

Millennium Ecosystem Assessment. (2003). *Ecosystems and human well-being: A framework for assessment*. Washington, D.C.: Island Press.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being*. Washington, D. C.: Island Press.

Miller, F., Osbahr, H., Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., et al. (2010). Resilience and vulnerability: Complementary or conflicting concepts. *Ecology and Society, 15*(3), 11.

Ministerio de Agricultura y Ganaderia, MAG. (1991). *Aspectos técnicos sobre cuarenta y cinco cultivos agrícolas de Costa Rica*. San Jose, Costa Rica.

Ministerio de Agricultura y Ganaderia,MAG. (2007). *Cadena agroalimentaria del cultivo de piña en distrito de Chires de Puriscal*. La Gloria, Costa Rica.

Mooney H, Cropper A, Reid W (2005) Confronting the human dilemma: How can ecosystems provide sustainable services to benefit society? *Nature 434*:561-562

Mora, A. M., van Wendel de Joode, B., Mergler, D., Córdoba, L., Cano, C., Quesada, R., ... & Eskenazi, B. (2014). Blood and hair manganese concentrations in pregnant women from the infants' environmental health study (ISA) in Costa Rica. *Environmental science & technology*, *48*(6), 3467-3476.

Municipality of Talamanca. (2003). *Plan local de desarrollo: 2003-2013*. Bribri, Talamanca, Costa Rica.

Murungweni, C., van Wijk, M. T., Anderson, J. A., Smaling, E. M. A., & Giller, K. E. (2011). Application of fuzzy cognitive mapping in livelihood vulnerability analysis. 16(4)

Nahlik, A. M., Kentula, M. E., Fennessy, M. S., & Landers, D. H. (2012). Where is the consensus? A proposed foundation for moving ecosystem service concepts into practice. *Ecological Economics, 77*, 27-35.

Namakura, K., Iwai, S., & Sawaragi, T. (1982). Decision support using causation knowledge base. *ISEE Transactions on Systems, Man, and Cybernetics,* 12(6), 765-777.

Narayan, D., Chambers, R., Shah, M. K., & Petesch, P. (2000). *Voices of the poor: Crying out for change* New York: Oxford University Press for the World Bank.

Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, D., et al. (2009). Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment, 7(1),* 4-11.

Norberg, J., & Cumming, G. S. (2008). In Norberg J., Cumming G. S. (Eds.), *Complexity theory for a sustainable future*. New York, NY, USA: Columbia University Press.

Norgaard, R. B. (2010). Ecosystem services: From eye-opening metaphor to complexity blinder. *Ecological Economics, 69*(6), 1219-1227.

Nussbaum, M. C. (2000). *Women and human development: The capabilities approach*. Cambridge, UK: Cambridge University Press.

Nussbaum, M., & Sen, A. (1993). *The quality of life*. Oxford, UK: Oxford University Press.

Olsson, P., Gunderson, L. H., Carpenter, S. R., Ryan, P., Lebel, L., Folke, C., et al. (2006). Shooting the rapids: Navigating transitions to adaptive governance of social-ecological systems. *Ecology and Society, 11*(1), 18.

Orozco, L., Villalobos, M., Ortiz, A., Riascos, L., Mendez, J., & Sanchez, V. (2008). Las fincas indígenas Bribri y Cabécar de Talamanca, Costa Rica. *Agroforestería en Las Américas, 46,* 14-20.

Özesmi, U., & Özesmi, S. (2004). Ecological models based on people's knowledge: A multi-step fuzzy cognitive mapping approach. *Ecological Modelling 176(1-2),* 43-64.

Özesmi, U., & Özesmi, S. L. (2003). A participatory approach to ecosystem conservation: Fuzzy cognitive maps and stakeholder group analysis in Uluabat lake, Turkey. *Environmental Management*, *31(4),* 518-531.

Papageorgiou, E. I., & Salmeron, J. L. (2012). A review of fuzzy cognitive maps research during the last decade. *Fuzzy Systems, IEEE Transactions on* (99)

Patton, M. Q. (2002). *Qualitative research and evaluation methods (3rd ed.).* Thousand Oaks, California: SAGE Publications.

Pelling, M. (2003). *The vulnerability of cities: Natural disasters and social resilience*. New York, NY, USA: Earthscan.

Pereira, E., Queiroz, C., Pereira, H. M., & Vicente, L. (2005). Ecosystem services and human well-being: A participatory study in a mountain community in Portugal. *Ecology & Society,* 10(2).

Perez-Brignoli, H. (1997). *Historia de Costa Rica, 1840-1940: Una sintesis interpretativa* (3rd ed.). San Jose, Costa Rica: UNED.

Peterson, G. (2000). Political ecology and ecological resilience: An integration of human and ecological dynamics. *Ecological Economics, 35*(3), 323-336.

Peterson, M. J., Hall, D. M., Feldpausch-Parker, A. M., & Peterson, T. R. (2010). Obscuring ecosystem function with application of the ecosystem services concept. *Conservation Biology, 24*(1), 113-119.

Pimm, S. L. (1984). The complexity and stability of ecosystems. *Nature, 307*(5949), 321-326.

Pinkerton, E. W. (1994). Local fisheries co-management: A review of international experiences and their implications for salmon management in British Columbia. *Canadian Journal of Fisheries and Aquatic Sciences, 51*(10), 2363-2378.

Plummer, R. (2009). The adaptive co-management process: An initial synthesis of representative models and influential variables. *Ecology and Society, 14*(2), 24.

Polidoro, B. A. (2007). *Ecological risk assessment of current-use pesticides in the Sixaola watershed, Costa Rica*. Unpublished Doctor of Philosophy, University of Idaho, Idaho.

Polidoro, B. A., Dahlquist, R. M., Castillo, L. E., Morra, M. J., Somarriba, E., & Bosque-Pérez, N. A. (2008). Pesticide application practices, pest knowledge, and cost-benefits of plantain production in the Bribri-Cabécar indigenous territories, Costa Rica. *Environmental Research, 108(1),* 98-106.

Polsby, N. W. (1960). How to study community power: The pluralist alternative. *The Journal of Politics, 22(3),* 474-484.

Potschin, M. B., & Haines-Young, R. H. (2011). Ecosystem services: Exploring a geographical perspective. *Progress in Physical Geography, 35*(5), 575-594.

Programa de las Naciones Unidas para el Desarrollo, PNUD. (2011). *Atlas del desarrollo humano cantonal de Costa Rica 2011*. San Jose, Costa Rica: Universidad de Costa Rica.

Promotora del Comercio Exterior Costa Rica (PROCOMER) (2009) *Estadísticas del comercio exterior de Costa Rica de 2008.* San Jose, Costa Rica

Rajaram, T., & Das, A. (2010). Modeling of interactions among sustainability components of an agro-ecosystem using local knowledge through cognitive mapping and fuzzy inference system. *Expert Systems with Applications, 37(2),* 1734-1744.

Ramsey, D. S. L., & Norbury, G. L. (2009). Predicting the unexpected: Using a qualitative model of a New Zealand dryland ecosystem to anticipate pest management outcomes. *Austral Ecology, 34(4),* 409-421.

Raudsepp-Hearne, C., Peterson, G. D., Tengö, M., Bennett, E. M., Holland, T., Benessaiah, K., et al. (2010). Untangling the environmentalist's paradox: Why is human well-being increasing as ecosystem services degrade? *BioScience, 60*(8), 576-589.

Raudsepp-Hearne, C., Peterson, G. D., & Bennett, E. M. (2010). Ecosystem service bundles for analyzing tradeoffs in diverse landscapes. *Proceedings of the National Academy of Sciences of the United States of America, 107*(11), 5242-5247.

Ravnborg, H. M. (2002). Poverty and soil management: Relationships from three Honduran watersheds. *Society & Natural Resources, 15*(6), 523-539.

Ravnborg, H. M. (2003). Poverty and environmental degradation in the Nicaraguan hillsides. *World Development, 31*(11), 1933-1946.

Raynolds, L. (2003). The global banana trade. In S. Striffler, & M. Moberg (Eds.), *Banana wars: Power, production, and history in the Americas* (pp. 23-47). Durham, North Carolina: Duke University Press.

Rist, L., Felton, A., Nyström, M., Troell, M., Sponseller, R. A., Bengtsson, J., . . . Angeler, D. (2014). Applying resilience thinking to production ecosystems. *Ecosphere, 5*(6),73.

Reyers, B., Biggs, R., Dziba, L., Gordon, L. J., Peterson, G. D., & Tengö, M. (submitted). Exploring and expanding the prospects of ecosystem services for poverty alleviation. *Bioscience.*

Rhodes, S. D., Hergenrather, K. C., Wilkin, A. M., & Jolly, C. (2008). Visions and voices: Indigent persons living with HIV in the southern united states use photovoice to create knowledge, develop partnerships, and take action. *Health Promotion Practice,* 9(2), 159-169.

Ribot, J. C. (1998). Theorizing access: Forest profits along Senegal's charcoal commodity chain. *Development and Change, 29*(2), 307-341.

Ribot, J. C., & Peluso, N. L. (2003). A theory of access. *Rural Sociology, 68*(2), 153-181.

Robertson, G. P., & Swinton, S. M. (2005). Reconciling agricultural productivity and environmental integrity: A grand challenge for agriculture. *Frontiers in Ecology and the Environment, 3*(1), 38-46.

Robinson, J. C., & Saúco, V. G. (2010). *Bananas and plantains.* CABI, Massachusetts, USA.

Rodríguez, J. P., Beard Jr, T. D., Bennett, E. M., Cumming, G. S., Cork, S., Agard, J., et al. (2006). Trade-offs across space, time, and ecosystem services. *Ecology and Society, 11*(1), 28.

Rojas-Conejo, D. (2002). *El conflicto entre tradición y modernidad: Constitución de la identidad cultural indígena Bribri*. San Jose, Costa Rica: FLACSO.

Ryan, G. W., & Bernard, H. R. (2003). Techniques to identify themes. *Field Methods,* 15(1), 85-109.

Saldaña, J. (2009). *The coding manual for qualitative researchers.* Thousand Oaks, California: Sage Publications.

Samper-Kutschbach, M. (1993). *El trabajo en la sociedad rural costarricense (1840-1940)* (2nd ed.). San Jose, Costa Rica: UNED.

Sandhu, H., & Sandhu, S. (2014). Linking ecosystem services with the constituents of human well-being for poverty alleviation in eastern Himalayas. *Ecological Economics, 107*, 65-75.

Sass R (2000) Agricultural "killing fields": The poisoning of Costa Rican banana workers. *International Journal of Health Services 30(3)*:491-514

Schattschneider, E. (1960). *The semi-sovereign people.* New York, NY, USA: Holt, Rinehart and Winston.

Scherr, S. J. (2000). A downward spiral? Research evidence on the relationship between poverty and natural resource degradation. *Food Policy, 25*(4), 479-498.

Secretaría Ejecutiva de Planificación Sectorial Agropecuaria, SEPSA. (2014). *Boletín estadístico agropecuario* No. 24). San Jose, Costa Rica:

Sen, A. (1988). *The standard of living* Cambridge University Press.

Sen, A. (1999). *Development as freedom* Oxford University Press.

Short RV (2006) New ways of preventing HIV infection: thinking simply, simply thinking. *Philosophical Transactions of the Royal Society B: Biological Sciences 361(1469*):811-820

Solano-Salazar E (2000) *La población indígena en Costa Rica según el censo 2000. In Rosero-Bixby L (ed), Costa Rica a la luz del censo 2000.* Centro Centroamericano de Población Universidad de Costa Rica, San Jose, Costa Rica, pp 341-373

Soler, L. S., Kok, K., Camara, G., & Veldkamp, A. (2012). Using fuzzy cognitive maps to describe current system dynamics and develop land cover scenarios: a case study in the Brazilian Amazon. *Journal of Land Use Science*, *7*(2), 149-175.

Streeten, P., & Burki, S. J. (1978). Basic needs: Some issues. *World Development, 6*(3), 411-421.

Streng JM, Rhodes S, Ayala G, Eng E, Arceo R, Phipps S (2004) Realidad Latina: Latino adolescents, their school, and a university use photovoice to examine and address the influence of immigration. *Journal of Professional Care* 18(4):403-415

TEEB (2010) *The economics of ecosystems and biodiversity: Ecological and economic foundations.* Earthscan, Washington, DC, 410 pp

Thompson, N. C., Hunter, E. E., Murray, L., Ninci, L., Rolfs, E. M., & Pallikkathayil, L. (2008). The experience of living with chronic mental illness: A photovoice study. *Perspectives in Psychiatric Care, 44(1),* 14-24.

Thrupp, L. A. (1991). Sterilization of workers from pesticide exposure: The causes and consequences of DBCP-induced damage in Costa Rica and beyond. *International Journal of Health Services, 21*(4), 731-757.

Turner NJ, Gregory R, Brooks C, Failing L, Satterfield T (2008) From invisibility to transparency: identifying the implications. *Ecology and Society 13(2):*7

Vagneron, I., Faure, G., & Loeillet, D. (2009). Is there a pilot in the chain? Identifying the key drivers of change in the fresh pineapple sector. *Food Policy, 34*(5), 437-446.

van Vliet, M., Kok, K., & Veldkamp, T. (2010). Linking stakeholders and modellers in scenario studies: The use of Fuzzy Cognitive Maps as a communication and learning tool. *Futures*, *42*(1), 1-14.

Van Wendel de Joode, B. V. W., Barraza, D., Ruepert, C., Mora, A. M., Córdoba, L., Öberg, M., ... & Lindh, C. H. (2012). Indigenous children living nearby plantations with chlorpyrifos-treated bags have elevated 3, 5, 6-trichloro-2-pyridinol (TCPy) urinary concentrations. *Environmental Research*, *117*, 17-26.

Van Wendel de Joode, B. V. W., Mora, A. M., Córdoba, L., Cano, J. C., Quesada, R., Faniband, M., ... & Lindh, C. H. (2014). Aerial Application of Mancozeb and Urinary Ethylene Thiourea (ETU) Concentrations among Pregnant Women in Costa Rica: The Infants' Environmental Health Study (ISA). *Environmental Health Perspectives*, *122*(12), 1321.

Villalba, U. (2013). Buen vivir vs development: A paradigm shift in the Andes? *Third World Quarterly, 34*(8), 1427-1442.

Viteri Gualinga, C. (2002). Visión indígena del desarrollo en la Amazonía. *Polis Revista Latinoamericana,* (3)

Wallace, K. J. (2007). Classification of ecosystem services: Problems and solutions. *Biological Conservation, 139*(3), 235-246.

Walters, C. J. (1986). *Adaptive management of renewable resources*. New York, NY, USA: MacMillan Press.

Waltner-Toews D, Kay JJ, Neudorerffer C, Gitau T (2003) Perspective changes everything: managing ecosystems from the inside out. *Frontiers in Ecology and the Environment 1(1)*:23-30

Wang, C. C. (1999). Photovoice: A participatory action research strategy applied to women's health. *Journal of Women's Health, 8(2),* 185-192.

Wang, C., & Burris, M. A. (1994). Empowerment through photo novella: Portraits of participation. *Health Education & Behavior, 21(2),* 171-186.

Wang, C., & Burris, M. A. (1997). Photovoice: Concept, methodology, and use for participatory needs assessment. *Health Education & Behavior : The Official Publication of the Society for Public Health Education, 24(3),* 369-387.

Wesseling C, Castillo L, Elinder CG (1993) Pesticide poisonings in Costa Rica. *Scandinavian Journal of Work, Environment & Health 19(4):*227-235

Wesseling, C., De Joode, Berna Van Wendel, & Monge, P. (2001). Pesticide-related illness and injuries among banana workers in Costa Rica: A comparison between 1993 and 1996. *International Journal of Occupational and Environmental Health, 7*(2), 90-97.

Westley, F., Carpenter, S. R., Brock, W. A., Holling, C., & Gunderson, L. H. (2002). Why systems of people and nature are not just social and ecological systems. In L. H. Gunderson, & C. S.

Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 103-119). Washington, D.C., USA: Island Press.

Westman, W. E. (1977). How much are nature's services worth? *Science, 197*(4307), 960-964.

Whelan, M. P. (2005). *Reading the Talamanca Landscape: Land use and Livelihoods in the Bribri and Cabécar Indigenous Territories,* unpublished thesis.

World Commission on Environment and Development. (1987). *Our common future*. Oxford, UK: Oxford University Press.

Yepez, J. P. (1999). *Talamanca frente al segundo milenio: Estrategias para el desarrollo sostenible.* Talamanca, Costa Rica: Proyecto Namasöl.

APPENDIX A

No. de mapa:	

Buenas, mi nombre es _____, y soy una estudiante de _____. Estamos trabajando en un proyecto sobre la relación entre el manejo de los recursos naturales y las condiciones de vida en comunidades agrícolas.

DATOS GENERALES

Fecha (día y mes):
Hora de inicio y fin:
Entrevistador(a):
Comunidad:
Nombre y apellidos:
Edad:
Género: ☐ Mujer ☐ Hombre
G1 ¿En que trabaja Ud.?
G2 Aproximadamente, ¿cuánto diría Ud. que depende de (recurso natural)? ☐ mas de la mitad ☐ menos de la mitad ☐ no sabe
G3 ¿Es dueño/a de su propia finca? ☐ Sí . ¿Cómo es de grande? ☐ No ☐ menos de 2 ha ☐ entre 2 y 10 ha ☐ más de 10 ha ( ) ¿Tienes Ud. caña también? ☐ Sí ☐ No
G4 ¿Es Ud. Costarricense? ☐ Sí ☐ No. ¿De dónde es Ud.?
G5 ¿Es Ud. miembro de un grupo Indígena? ☐ Sí , ¿cuál? ☐ No

Notas:

No. de mapa:	

El ejercicio que vamos a hacer es un mapa de ideas. Yo le voy a hacer un ejemplo primero para explicarle a Ud. Imagine que Ud. me pregunta, ¿cómo se mejorarían las escuelas? [Dibuje un mapa] ¿Tiene alguna pregunta?

Ahora vamos a hacer uno donde Ud. me indica lo que poner. La pregunta es:

¿De qué depende usted para sentirse bien y estar tranquilo/a?

¿De qué depende su salud?

que usted se sienta sano/a, saludable?

¿De qué depende que Ud. se lleve bien con otras personas (su familia, sus amigos, su comunidad)?

¿De qué depende que Ud. se sienta seguro/a?

de que nadie le vaya a dañar o quitar sus cosas?

¿Hay cosas que le dan temor a Ud donde Ud. vive?

¿De qué depende que Ud. pueda cubrir sus necesidades materiales?

Casa, comida, ropa…?

¿Cómo el ambiente y los recursos naturales - como el agua, aire, vegetación, etc - influyen en esas cosas (en que se sienta Ud. bien y tranquilo/a)?

¿Hay algo que le preocupa sobre su ambiente?

Ahora Ud. me va a decir cuáles de estas cosas están relacionadas. [Dibuje flechas con signos positivos (si más de una cosa, es mas de otra cosa) o negativos (si más de una cosa, es menos de otra cosa). Para cada relación que la persona identifique pídale que señale en la escala si influye mucho o poco y anote el número (aproximadamente)].

El ejercicio se acaba cuando la persona no tenga más que añadir. Apunte la hora que termino la entrevista.

Comentarios o notas:

APPENDIX B

TABLES AND MATRIXES FOR FCMS BY DEMOGRAPHIC CATEGORY

Table B-1 – Table of relationships identified by residents in Matina (n= 29) used to calculate the weights in the augmented matrix (FW stands for female plantation workers, FHW stands for female housewives, MNC stands for Nicaraguan males, MCR stands for Costa Rican males).

	Number of interviews	=	29																																
	Variable	Polarity		Variable	M019	M021	M023	M024	M025	M027	M041	M001	M003	M026	M030	M034	M035	M047	M049	M002	M006	M007	M010	M013	M020	M004	M005	M008	M015	M016	M018	M028	M029	Frequency	Avg. Weight	Matrix weight
E1	Floods	-1	H1	Feeling healthy			MNC					FW			FW			FW				FHW							MCR					6	0.21	-0.21
E1	Floods	1	M12	Economic need (scarcity)		MNC					MNC	FW	FW	FW		FW	FW		FW			FHW	FHW	FHW	FHW				MCR	MCR		MCR		15	0.52	0.52
H10	Fatigue	-1	H1	Feeling healthy	MNC						MNC							FW							MCR							MCR	MCR	6	0.21	-0.21
H11	Dengue	-1	H1	Feeling healthy								FW			FW					FHW		FHW	FHW											5	0.17	-0.17
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	MNC		MNC		MNC		MNC			FW	FW	FW		FW	FW		FHW		FHW			MCR	MCR	MCR	MCR	MCR	MCR	MCR	MCR	19	0.66	-0.66
H4	Emotional stress	-1	H1	Feeling healthy				MNC						FW						FHW			FHW				MCR			MCR	MCR			7	0.24	-0.24
M1	Having the materials for good life	1	H1	Feeling healthy	MNC							FW								FHW			FHW		FHW	MCR	MCR							7	0.24	0.24
M10	Variable income	1	M12	Economic need (scarcity)	MNC		MNC	MNC	MNC		MNC	FW		FW	FW	FW				FHW	FHW	FHW			FHW									13	0.45	0.45
M12	Economic need (scarcity)	-1	M1	Having the materials for good life																						MCR	MCR	MCR		MCR	MCR	MCR	MCR	7	0.24	-0.24
M2	Being employed	1	H10	Fatigue	MNC									FW		FW	FW	FW	FW			FHW					MCR		MCR			MCR	MCR	11	0.38	0.38
M2	Being employed	1	M1	Having the materials for good life	MNC	MNC				MNC										FHW										MCR		MCR		6	0.21	0.21
M3	In-kind payment of basic needs	1	M1	Having the materials for good life					MNC				FW								FHW					MCR		MCR	MCR	MCR				7	0.24	0.24
M6	Increasing cost of living	1	M12	Economic need (scarcity)	MNC		MNC	MNC				FW		FW												MCR	MCR							7	0.24	0.24
M9	Presence of banana companies	1	E1	Floods			MNC															FHW							MCR	MCR	MCR		MCR	6	0.21	0.21
M9	Presence of banana companies	1	H2	Exposure to agrochemicals	MNC				MNC						FW	FW		FW				FHW	FHW				MCR	MCR	MCR					10	0.34	0.34
M9	Presence of banana companies	1	M2	Being employed		MNC																FHW												2	0.07	0.07
R19	Knowing people in communtiy	1	R1	Having good social relations			MNC	MNC				FW																	MCR					4	0.14	0.14
R21	Family breakdown	1	R23	Unoccupied youth									FW	FW		FW																		3	0.10	0.10
R23	Unoccupied youth	1	S6	Presence of crime			MNC				MNC				FW	FW		FW	FW	FHW		FHW			FHW	MCR			MCR		MCR	MCR		13	0.45	0.45
R24	Transient population	-1	R1	Having good social relations		MNC										FW																		2	0.07	-0.07
R32	Community projects	1	R19	Knowing people in communtiy																									MCR	MCR	MCR			3	0.10	0.10
R3	Relations with co-workers	1	R1	Having good social relations				MNC	MNC															FHW			MCR							MCR	5	0.17	0.17
R4	Keeping to oneself	1	R1	Having good social relations		MNC		MNC					FW		FW		FW	FW	FW	FHW			FHW	FHW		MCR		MCR			MCR	MCR	MCR	15	0.52	0.52
R4	Keeping to oneself	1	R28	Social isolation	MNC	MNC			MNC		MNC			FW		FW	FW	FW	FW			FHW	FHW	FHW								MCR		13	0.45	0.45
R4	Keeping to oneself	1	S1	Feeling safe	MNC						MNC																							2	0.07	0.07
S2	Being vigilant	1	S1	Feeling safe													FW	FW		FHW		FHW				MCR					MCR		MCR	7	0.24	0.24
S3	Impunity (soft laws)	-1	S1	Feeling safe		MNC					MNC				FW							FHW	FHW	FHW			MCR		MCR	MCR	MCR	MCR	MCR	12	0.41	-0.41
S4	Presence of drug traffic	1	S6	Presence of crime		MNC	MNC					FW	FW	FW								FHW		FHW		MCR	MCR	MCR						10	0.34	0.34
S6	Presence of crime	1	R21	Family breakdown		MNC							FW	FW							FHW		FHW											5	0.17	0.17
S6	Presence of crime	1	R4	Keeping to oneself				MNC			MNC				FW		FW			FHW		FHW												6	0.21	0.21
S6	Presence of crime	-1	S1	Feeling safe		MNC	MNC		MNC				FW	FW	FW	FW	FW	FW		FHW		FHW	FHW	FHW	FHW	MCR	MCR	MCR	MCR	MCR	MCR	MCR	MCR	22	0.76	-0.76
W3	Being a good worker	1	M2	Being employed	MNC				MNC	MNC			FW													MCR		MCR				MCR		7	0.24	0.24
W30	Piece work	1	M10	Variable income				MNC	MNC		MNC		FW				FW			FHW					FHW				MCR		MCR			9	0.31	0.31
W31	Personal protection equipment	-1	H2	Exposure to agrochemicals			MNC		MNC	MNC	MNC			FW			FW	FW	FW															8	0.28	-0.28
W34	Work accidents	-1	H1	Feeling healthy	MNC						MNC			FW		FW						FHW												5	0.17	-0.17
W4	Dubious labour practices	1	H4	Emotional stress										FW				FW				FHW												3	0.10	0.10
W4	Dubious labour practices	1	W18	Sense of unfairness/exploitation	MNC			MNC	MNC		MNC			FW		FW		FW															MCR		8	0.28	0.28
W7	Lack of time	-1	R1	Having good social relations						MNC	MNC		FW	FW	FW							FHW									MCR		MCR	8	0.28	-0.28

Table B – 2 – Augmented matrix representing human well-being in Matina (n=29)

		E1	H1	H10	H11	H2	H4	M1	M10	M12	M2	M3	M6	M9	R1	R19	R21	R23	R24	R28	R3	R32	R4	S1	S2	S3	S4	S6	W18	W3	W30	W31	W34	W4	W7
		Floods	Feeling healthy	Fatigue	Dengue	Exposure to agrochemicals	Emotional stress	Having the materials for good life	Variable income	Economic need (scarcity)	Being employed	In-kind payment of basic needs	Increasing cost of living	Presence of banana companies	Having good social relations	Knowing people in communtiy	Family breakdown	Unoccupied youth	Transient population	Social isolation	Relations with co-workers	Community projects	Keeping to oneself	Feeling safe	Being vigilant	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Sense of unfairness/exploitation	Being a good worker	Piece work	Personal protection equipment	Work accidents	Dubious labour practices	Lack of time
E1	Floods		-0.21							0.52																									
H1	Feeling healthy																																		
H10	Fatigue		-0.21																																
H11	Dengue		-0.17																																
H2	Exposure to agrochemicals		-0.66																																
H4	Emotional stress		-0.24																																
M1	Having the materials for good life		0.24																																
M10	Variable income									0.45																									
M12	Economic need (scarcity)							-0.24																											
M2	Being employed			0.38				0.21																											
M3	In-kind payment of basic needs							0.24																											
M6	Increasing cost of living									0.24																									
M9	Presence of banana companies	0.21				0.34					0.07																								
R1	Having good social relations																																		
R19	Knowing people in communtiy														0.14																				
R21	Family breakdown																	0.1																	
R23	Unoccupied youth																											0.45							
R24	Transient population														-0.07																				
R28	Social isolation																																		
R3	Relations with co-workers														0.17																				
R32	Community projects															0.1																			
R4	Keeping to oneself														0.52					0.45				0.07											
S1	Feeling safe																																		
S2	Being vigilant																							0.24											
S3	Impunity (soft laws)																							-0.41											
S4	Presence of drug traffic																											0.34							
S6	Presence of crime																0.17						0.21	-0.76											
W18	Sense of unfairness/exploitation																																		
W3	Being a good worker										0.24																								
W30	Piece work								0.31																										
W31	Personal protection equipment					-0.28																													
W34	Work accidents		-0.17																																
W4	Dubious labour practices						0.1																						0.28						
W7	Lack of time														-0.28																				

Table B – 3 – Table of relationships identified by Nicaraguan male plantation workers living in Matina used to calculate the weights of their corresponding matrix (n=7).

Number of interviews = 7

	Variable	Polarity		Variable	M019	M021	M023	M024	M025	M027	M041	Frequency	Avg. Weight	Matrix weight
E1	Floods	-1	H1	Feeling healthy			MNC					1	0.14	**-0.14**
E1	Floods	1	M12	Economic need (scarcity)		MNC					MNC	2	0.29	**0.29**
H10	Fatigue	-1	H1	Feeling healthy	MNC						MNC	2	0.29	**-0.29**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	MNC		MNC		MNC		MNC	4	0.57	**-0.57**
H4	Emotional stress	-1	H1	Feeling healthy				MNC				1	0.14	**-0.14**
M1	Having the materials for good life	1	H1	Feeling healthy	MNC							1	0.14	**0.14**
M10	Variable income	1	M12	Economic need (scarcity)	MNC		MNC	MNC	MNC		MNC	5	0.71	**0.71**
M2	Being employed	1	H10	Fatigue	MNC							1	0.14	**0.14**
M2	Being employed	1	M1	Having the materials for good life	MNC	MNC				MNC		3	0.43	**0.43**
M3	In-kind payment of basic needs	1	M1	Having the materials for good life					MNC			1	0.14	**0.14**
M6	Increasing cost of living	1	M12	Economic need (scarcity)	MNC		MNC	MNC				3	0.43	**0.43**
M9	Presence of banana companies	1	E1	Floods			MNC					1	0.14	**0.14**
M9	Presence of banana companies	1	H2	Exposure to agrochemicals	MNC				MNC			2	0.29	**0.29**
M9	Presence of banana companies	1	M2	Being employed		MNC						1	0.14	**0.14**
R19	Knowing people in communtiy	1	R1	Having good social relations			MNC	MNC				2	0.29	**0.29**
R23	Unoccupied youth	1	S6	Presence of crime			MNC				MNC	2	0.29	**0.29**
R24	Transient population	-1	R1	Having good social relations		MNC						1	0.14	**-0.14**
R3	Relations with co-workers	1	R1	Having good social relations				MNC	MNC			2	0.29	**0.29**
R4	Keeping to oneself	1	R1	Having good social relations		MNC		MNC				2	0.29	**0.29**
R4	Keeping to oneself	1	R28	Social isolation	MNC	MNC			MNC		MNC	4	0.57	**0.57**
R4	Keeping to oneself	1	S1	Feeling safe	MNC						MNC	2	0.29	**0.29**
S3	Impunity (soft laws)	-1	S1	Feeling safe		MNC					MNC	2	0.29	**-0.29**
S4	Presence of drug traffic	1	S6	Presence of crime		MNC	MNC					2	0.29	**0.29**
S6	Presence of crime	1	R21	Family breakdown		MNC						1	0.14	**0.14**
S6	Presence of crime	1	R4	Keeping to oneself				MNC			MNC	2	0.29	**0.29**
S6	Presence of crime	-1	S1	Feeling safe		MNC	MNC		MNC			3	0.43	**-0.43**
W3	Being a good worker	1	M2	Being employed	MNC				MNC	MNC		3	0.43	**0.43**
W30	Piece work	1	M10	Variable income				MNC	MNC		MNC	3	0.43	**0.43**
W31	Personal protection equipment	-1	H2	Exposure to agrochemicals			MNC		MNC	MNC	MNC	4	0.57	**-0.57**
W34	Work accidents	-1	H1	Feeling healthy	MNC						MNC	2	0.29	**-0.29**
W4	Dubious labour practices	1	W18	Sense of unfairness/exploitation	MNC			MNC	MNC		MNC	4	0.57	**0.57**
W7	Lack of time	-1	R1	Having good social relations						MNC	MNC	2	0.29	**-0.29**

Table B –4. Matrix of human well-being from the perspective of Nicaraguan male plantation workers living in Matina (n=7)

		E1	H1	H10	H2	H4	M1	M10	M12	M2	M3	M6	M9	R1	R19	R21	R23	R24	R28	R3	R4	S1	S3	S4	S6	W18	W3	W30	W31	W34	W4	W7
		Floods	Feeling healthy	Fatigue	Exposure to agrochemicals	Emotional stress	Having the materials for good life	Variable income	Economic need (scarcity)	Being employed	In-kind payment of basic needs	Increasing cost of living	Presence of banana companies	Having good social relations	Knowing people in communtiy	Family breakdown	Unoccupied youth	Transient population	Social isolation	Relations with co-workers	Keeping to oneself	Feeling safe	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Sense of unfairness/exploitation	Being a good worker	Piece work	Personal protection equipment	Work accidents	Dubious labour practices	Lack of time
E1	Floods		-0.14						0.29																							
H1	Feeling healthy																															
H10	Fatigue		-0.29																													
H2	Exposure to agrochemicals		-0.57																													
H4	Emotional stress		-0.14																													
M1	Having the materials for good life		0.14																													
M10	Variable income								0.71																							
M12	Economic need (scarcity)																															
M2	Being employed			0.14			0.43																									
M3	In-kind payment of basic needs						0.14																									
M6	Increasing cost of living								0.43																							
M9	Presence of banana companies	0.14			0.29					0.14																						
R1	Having good social relations																															
R19	Knowing people in communtiy													0.29																		
R21	Family breakdown																															
R23	Unoccupied youth																								0.29							
R24	Transient population													-0.14																		
R28	Social isolation																															
R3	Relations with co-workers													0.29																		
R4	Keeping to oneself													0.29					0.6			0										
S1	Feeling safe																															
S3	Impunity (soft laws)																					-0										
S4	Presence of drug traffic																								0.29							
S6	Presence of crime															0.14					0.3	-0										
W18	Sense of unfairness/exploitation																															
W3	Being a good worker									0.43																						
W30	Piece work							0.4																								
W31	Personal protection equipment				-0.6																											
W34	Work accidents		-0.29																													
W4	Dubious labour practices																									0.57						
W7	Lack of time													-0.29																		

Table B –5. Table of relationships identified by Costa Rican male plantation workers living in Matina used to calculate the weights of their corresponding matrix (n=8).

Number of interviews = 8

	Variable	Polarity		Variable	M004	M005	M008	M015	M016	M018	M028	M029	Frequency	Avg. Weight	Matrix weight
E1	Floods	-1	H1	Feeling healthy				MCR					1	0.13	**-0.13**
E1	Floods	1	M12	Economic need (scarcity)				MCR	MCR		MCR		3	0.38	**0.38**
H10	Fatigue	-1	H1	Feeling healthy	MCR						MCR	MCR	3	0.38	**-0.38**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	MCR	MCR	MCR	MCR	MCR	MCR	MCR	MCR	8	1.00	**-1.00**
H4	Emotional stress	-1	H1	Feeling healthy		MCR			MCR	MCR			3	0.38	**-0.38**
M1	Having the materials for good life	1	H1	Feeling healthy	MCR	MCR							2	0.25	**0.25**
M12	Economic need (scarcity)	-1	M1	Having the materials for good life	MCR	MCR	MCR		MCR	MCR	MCR	MCR	7	0.88	**-0.88**
M2	Being employed	1	H10	Fatigue		MCR		MCR			MCR	MCR	4	0.50	**0.50**
M2	Being employed	1	M1	Having the materials for good life					MCR		MCR		2	0.25	**0.25**
M3	In-kind payment of basic needs	1	M1	Having the materials for good life	MCR		MCR	MCR	MCR				4	0.50	**0.50**
M6	Increasing cost of living	1	M12	Economic need (scarcity)	MCR	MCR							2	0.25	**0.25**
M9	Presence of banana companies	1	E1	Floods				MCR	MCR	MCR		MCR	4	0.50	**0.50**
M9	Presence of banana companies	1	H2	Exposure to agrochemicals		MCR	MCR	MCR					3	0.38	**0.38**
R19	Knowing people in communtiy	1	R1	Having good social relations				MCR					1	0.13	**0.13**
R23	Unoccupied youth	1	S6	Presence of crime	MCR			MCR		MCR	MCR		4	0.50	**0.50**
R3	Relations with co-workers	1	R1	Having good social relations		MCR						MCR	2	0.25	**0.25**
R32	Community projects	1	R19	Knowing people in communtiy				MCR	MCR	MCR			3	0.38	**0.38**
R4	Keeping to oneself	1	R1	Having good social relations	MCR		MCR			MCR	MCR	MCR	5	0.63	**0.63**
R4	Keeping to oneself	1	R28	Social isolation							MCR		1	0.13	**0.13**
S2	Being vigilant	1	S1	Feeling safe	MCR					MCR		MCR	3	0.38	**0.38**
S3	Impunity (soft laws)	-1	S1	Feeling safe		MCR		MCR	MCR	MCR	MCR	MCR	6	0.75	**-0.75**
S4	Presence of drug traffic	1	S6	Presence of crime	MCR	MCR	MCR						3	0.38	**0.38**
S6	Presence of crime	-1	S1	Feeling safe	MCR	MCR	MCR	MCR	MCR	MCR	MCR	MCR	8	1.00	**-1.00**
W3	Being a good worker	1	M2	Being employed	MCR		MCR				MCR		3	0.38	**0.38**
W30	Piece work	1	M10	Variable income				MCR		MCR			2	0.25	**0.25**
W4	Dubious labour practices	1	W18	Sense of unfairness/exploitation							MCR		1	0.13	**0.13**
W7	Lack of time	-1	R1	Having good social relations						MCR		MCR	2	0.25	**-0.25**

Table B – 6. Matrix of human well-being from the perspective of Costa Rican male plantation workers living in Matina (n=8).

		E1	H1	H10	H2	H4	M1	M10	M12	M2	M3	M6	M9	R1	R19	R23	R28	R3	R32	R4	S1	S2	S3	S4	S6	W18	W3	W30	W4	W7
		Floods	Feeling healthy	Fatigue	Exposure to agrochemicals	Emotional stress	Having the materials for good life	Variable income	Economic need (scarcity)	Being employed	In-kind payment of basic needs	Increasing cost of living	Presence of banana companies	Having good social relations	Knowing people in communtiy	Unoccupied youth	Social isolation	Relations with co-workers	Community projects	Keeping to oneself	Feeling safe	Being vigilant	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Sense of unfairness/exploitation	Being a good worker	Piece work	Dubious labour practices	Lack of time
E1	Floods		-0.1						0.38																					
H1	Feeling healthy																													
H10	Fatigue		-0.4																											
H2	Exposure to agrochemicals		-1																											
H4	Emotional stress		-0.4																											
M1	Having the materials for good life		0.25																											
M10	Variable income																													
M12	Economic need (scarcity)						-0.9																							
M2	Being employed			0.5			0.25																							
M3	In-kind payment of basic needs						0.5																							
M6	Increasing cost of living								0.25																					
M9	Presence of banana companies	0.5			0.38																									
R1	Having good social relations																													
R19	Knowing people in communtiy													0.13																
R23	Unoccupied youth																								0.5					
R28	Social isolation																													
R3	Relations with co-workers													0.25																
R32	Community projects														0.38															
R4	Keeping to oneself													0.63			0.13													
S1	Feeling safe																													
S2	Being vigilant																				0.38									
S3	Impunity (soft laws)																				-0.8									
S4	Presence of drug traffic																								0.38					
S6	Presence of crime																				-1									
W18	Sense of unfairness/exploitation																												0.13	
W3	Being a good worker									0.38																				
W30	Piece work							0.25																						
W4	Dubious labour practices																													
W7	Lack of time													-0.3																

Table B – 7. Table of relationships identified by female housewives living in Matina used to calculate the weights of their corresponding matrix (n=6).

Number of interviews = 6

	Variable	Polarity		Variable	M002	M006	M007	M010	M013	M020	Frequency	Avg. Weight	Matrix weight
E1	Floods	-1	H1	Feeling healthy			FHW				1	0.17	-0.17
E1	Floods	1	M12	Economic need (scarcity)			FHW	FHW	FHW	FHW	4	0.67	0.67
H11	Dengue	-1	H1	Feeling healthy	FHW		FHW	FHW			3	0.50	-0.50
H2	Exposure to agrochemicals	-1	H1	Feeling healthy		FHW		FHW			2	0.33	-0.33
H4	Emotional stress	-1	H1	Feeling healthy	FHW			FHW			2	0.33	-0.33
M1	Having the materials for good life	1	H1	Feeling healthy	FHW			FHW		FHW	3	0.50	0.50
M10	Variable income	1	M12	Economic need (scarcity)	FHW	FHW	FHW			FHW	4	0.67	0.67
M2	Being employed	1	H10	Fatigue			FHW				1	0.17	0.17
M2	Being employed	1	M1	Having the materials for good life	FHW						1	0.17	0.17
M3	In-kind payment of basic needs	1	M1	Having the materials for good life		FHW					1	0.17	0.17
M9	Presence of banana companies	1	E1	Floods			FHW				1	0.17	0.17
M9	Presence of banana companies	1	H2	Exposure to agrochemicals			FHW	FHW			2	0.33	0.33
M9	Presence of banana companies	1	M2	Being employed			FHW				1	0.17	0.17
R23	Unoccupied youth	1	S6	Presence of crime	FHW		FHW			FHW	3	0.50	0.50
R3	Relations with co-workers	1	R1	Having good social relations					FHW		1	0.17	0.17
R4	Keeping to oneself	1	R1	Having good social relations	FHW			FHW	FHW		3	0.50	0.50
R4	Keeping to oneself	1	R28	Social isolation			FHW	FHW	FHW		3	0.50	0.50
S2	Being vigilant	1	S1	Feeling safe	FHW		FHW				2	0.33	0.33
S3	Impunity (soft laws)	-1	S1	Feeling safe			FHW	FHW	FHW		3	0.50	-0.50
S4	Presence of drug traffic	1	S6	Presence of crime			FHW		FHW		2	0.33	0.33
S6	Presence of crime	1	R21	Family breakdown		FHW		FHW			2	0.33	0.33
S6	Presence of crime	1	R4	Keeping to oneself	FHW		FHW				2	0.33	0.33
S6	Presence of crime	-1	S1	Feeling safe	FHW		FHW	FHW	FHW	FHW	5	0.83	-0.83
W30	Piece work	1	M10	Variable income	FHW					FHW	2	0.33	0.33
W34	Work accidents	-1	H1	Feeling healthy			FHW				1	0.17	-0.17
W4	Dubious labour practices	1	H4	Emotional stress			FHW				1	0.17	0.17
W7	Lack of time	-1	R1	Having good social relations			FHW				1	0.17	-0.17

Table B – 8. Matrix of human well-being from the perspective of female housewives in Matina (n=6)

		E1	H1	H10	H11	H2	H4	M1	M10	M12	M2	M3	M9	R1	R21	R23	R28	R3	R4	S1	S2	S3	S4	S6	W30	W34	W4	W7
		Floods	Feeling healthy	Fatigue	Dengue	Exposure to agrochemicals	Emotional stress	Having the materials for good life	Variable income	Economic need (scarcity)	Being employed	In-kind payment of basic needs	Presence of banana companies	Having good social relations	Family breakdown	Unoccupied youth	Social isolation	Relations with co-workers	Keeping to oneself	Feeling safe	Being vigilant	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Piece work	Work accidents	Dubious labour practices	Lack of time
E1	Floods		-0.17							0.67																		
H1	Feeling healthy																											
H10	Fatigue																											
H11	Dengue		-0.5																									
H2	Exposure to agrochemicals		-0.33																									
H4	Emotional stress		-0.33																									
M1	Having the materials for good life		0.5																									
M10	Variable income									0.67																		
M12	Economic need (scarcity)																											
M2	Being employed			0.17				0.17																				
M3	In-kind payment of basic needs							0.17																				
M9	Presence of banana companies	0.17				0.33					0.17																	
R1	Having good social relations																											
R21	Family breakdown																											
R23	Unoccupied youth																							0.5				
R28	Social isolation																											
R3	Relations with co-workers													0.17														
R4	Keeping to oneself													0.5			0.5											
S1	Feeling safe																											
S2	Being vigilant																			0.33								
S3	Impunity (soft laws)																			-0.5								
S4	Presence of drug traffic																							0.33				
S6	Presence of crime														0.33				0.33	-0.83								
W30	Piece work								0.33																			
W34	Work accidents		-0.17																									
W4	Dubious labour practices						0.17																					
W7	Lack of time													-0.17														

Table B – 9. Table of relationships identified by female plantation workers in Matina used to calculate the weights of their corresponding matrix (n=8)

Number of interviews = 8

	Variable	Polarity		Variable	M001	M003	M026	M030	M034	M035	M047	M049	Frequency	Avg. Weight	Matrix weight
E1	Floods	-1	H1	Feeling healthy	FW			FW			FW		3	0.38	-0.38
E1	Floods	1	M12	Economic need (scarcity)	FW	FW	FW		FW	FW		FW	6	0.75	0.75
H10	Fatigue	-1	H1	Feeling healthy							FW		1	0.13	-0.13
H11	Dengue	-1	H1	Feeling healthy	FW			FW					2	0.25	-0.25
H2	Exposure to agrochemicals	-1	H1	Feeling healthy			FW	FW	FW		FW	FW	5	0.63	-0.63
H4	Emotional stress	-1	H1	Feeling healthy			FW						1	0.13	-0.13
M1	Having the materials for good life	1	H1	Feeling healthy	FW								1	0.13	0.13
M10	Variable income	1	M12	Economic need (scarcity)	FW		FW	FW	FW				4	0.50	0.50
M2	Being employed	1	H10	Fatigue			FW		FW	FW	FW	FW	5	0.63	0.63
M3	In-kind payment of basic needs	1	M1	Having the materials for good life		FW							1	0.13	0.13
M6	Increasing cost of living	1	M12	Economic need (scarcity)	FW		FW						2	0.25	0.25
M9	Presence of banana companies	1	H2	Exposure to agrochemicals				FW	FW		FW		3	0.38	0.38
R19	Knowing people in communtiy	1	R1	Having good social relations	FW								1	0.13	0.13
R21	Family breakdown	1	R23	Unoccupied youth		FW	FW		FW				3	0.38	0.38
R23	Unoccupied youth	1	S6	Presence of crime				FW	FW		FW	FW	4	0.50	0.50
R24	Transient population	-1	R1	Having good social relations					FW				1	0.13	-0.13
R4	Keeping to oneself	1	R1	Having good social relations		FW		FW		FW	FW	FW	5	0.63	0.63
R4	Keeping to oneself	1	R28	Social isolation			FW		FW	FW	FW	FW	5	0.63	0.63
S2	Being vigilant	1	S1	Feeling safe						FW	FW		2	0.25	0.25
S3	Impunity (soft laws)	-1	S1	Feeling safe				FW					1	0.13	-0.13
S4	Presence of drug traffic	1	S6	Presence of crime	FW	FW	FW						3	0.38	0.38
S6	Presence of crime	1	R21	Family breakdown		FW	FW						2	0.25	0.25
S6	Presence of crime	1	R4	Keeping to oneself				FW		FW			2	0.25	0.25
S6	Presence of crime	-1	S1	Feeling safe		FW	FW	FW	FW	FW	FW		6	0.75	-0.75
W3	Being a good worker	1	M2	Being employed		FW							1	0.13	0.13
W30	Piece work	1	M10	Variable income		FW				FW			2	0.25	0.25
W31	Personal protection equipment	-1	H2	Exposure to agrochemicals			FW			FW	FW	FW	4	0.50	-0.50
W34	Work accidents	-1	H1	Feeling healthy			FW		FW				2	0.25	-0.25
W4	Dubious labour practices	1	H4	Emotional stress			FW				FW		2	0.25	0.25
W4	Dubious labour practices	1	W18	Sense of unfairness/exploitation			FW		FW		FW		3	0.38	0.38
W7	Lack of time	-1	R1	Having good social relations		FW	FW	FW					3	0.38	-0.38

Table B – 10. Matrix of human well-being from the perspective of female plantation workers in Matina (n=8)

		E1	H1	H10	H11	H2	H4	M1	M10	M12	M2	M3	M6	M9	R1	R19	R21	R23	R24	R28	R4	S1	S2	S3	S4	S6	W18	W3	W30	W31	W34	W4	W7
		Floods	Feeling healthy	Fatigue	Dengue	Exposure to agrochemicals	Emotional stress	Having the materials for good life	Variable income	Economic need (scarcity)	Being employed	In-kind payment of basic needs	Increasing cost of living	Presence of banana companies	Having good social relations	Knowing people in communtiy	Family breakdown	Unoccupied youth	Transient population	Social isolation	Keeping to oneself	Feeling safe	Being vigilant	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Sense of unfairness/exploitation	Being a good worker	Piece work	Personal protection equipment	Work accidents	Dubious labour practices	Lack of time
E1	Floods		-0.4								0.75																						
H1	Feeling healthy																																
H10	Fatigue		-0.1																														
H11	Dengue		-0.3																														
H2	Exposure to agrochemicals		-0.6																														
H4	Emotional stress		-0.1																														
M1	Having the materials for good life		0.13																														
M10	Variable income									0.5																							
M12	Economic need (scarcity)																																
M2	Being employed			0.63																													
M3	In-kind payment of basic needs							0.13																									
M6	Increasing cost of living									0.25																							
M9	Presence of banana companies					0.38																											
R1	Having good social relations																																
R19	Knowing people in communtiy														0.13																		
R21	Family breakdown																	0.38															
R23	Unoccupied youth																									0.5							
R24	Transient population														-0.1																		
R28	Social isolation																																
R4	Keeping to oneself														0.63					0.63													
S1	Feeling safe																																
S2	Being vigilant																					0.25											
S3	Impunity (soft laws)																					-0.1											
S4	Presence of drug traffic																									0.38							
S6	Presence of crime																0.25				0.25	-0.8											
W18	Sense of unfairness/exploitation																																
W3	Being a good worker										0.13																						
W30	Piece work								0.25																								
W31	Personal protection equipment					-0.5																											
W34	Work accidents		-0.3																														
W4	Dubious labour practices						0.25																				0.38						
W7	Lack of time														-0.4																		

Table B – 11. Table of relationships identified by residents in the Bribri Indigenous Territory (n=38) used to calculate the weights in the augmented matrix (FS stands for females from Suretka-Shiroles, MS stands for males from Suretka-Shiroles, FA stands for females from Amubrë, MA stands for males from Amubrë).

Participants = 38

	Variable	Polarity		Variable	T002	T010	T012	T013	T014	T020	T024	T034	T043	T004	T006	T007	T008	T009	T011	T016	T017	T018	T019	T021	T022	T026	T027	T030	T031	T035	T037	T039	T042	T023	T025	T028	T029	T032	T036	T038	T040	T041	Frequency	Avg. weight	Matrix weights
E1	Floods	1	M12	Economic need (scarcity)			FS						FS			MS	MS		MS			MS	MS		MA			MA			MA			FA	FA	FA	FA					FA	15	0.39	**0.4**
E14	Pressure on resources from outside	1	E7	Environmental degradation				FS	FS	FS	FS	FS				MS			MS							MA			MA			MA	MA	MA		FA	FA	FA	FA	FA					16	0.42	**0.4**
E7	Environmental degradation	-1	H1	Feeling healthy			FS		FS		FS		FS			MS	MS	MS	MS		MS		MS		MA				MA		MA	MA						FA					15	0.39	**-0.4**
G5	Distrust on governing body	1	W21	Presence of intermediaries																			MS				MA	MA			MA		MA										5	0.13	**0.1**
H1	Feeling healthy	-1	M12	Economic need (scarcity)		FS	FS			FS	FS																																4	0.11	**-0.1**
H1	Feeling healthy	1	M2	Being employed					FS		FS																																2	0.05	**0.1**
H12	Traditional diet	1	H1	Feeling healthy	FS		FS	FS		FS	FS							MS	MS	MS		MS		MA		MA		MA	MA		MA	MA	MA	FA	FA	FA	FA		FA	FA			22	0.58	**0.6**
H12	Traditional diet	-1	H18	New diseases																														FA	FA	FA			FA	FA			5	0.13	**-0.1**
H16	Traditional medicine	1	H1	Feeling healthy						FS							MS										MA							FA									4	0.11	**0.1**
H18	New diseases	-1	H1	Feeling healthy			FS		FS						MS		MS	MS																FA	FA	FA			FA	FA			10	0.26	**-0.3**
H19	Emotional stress	-1	H1	Feeling healthy		FS	FS	FS				FS																									FA			FA	FA		7	0.18	**-0.2**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	FS	FS		FS		FS		FS	FS		MS		MS			MS				MA	MA			MA		MA	MA		MA		FA				FA			17	0.45	**-0.4**
M12	Economic need (scarcity)	-1	M1	Having the materials for good life						FS		FS	FS								MS		MS	MA	MA	MA			MA	MA	MA		MA	FA	FA	FA	FA	FA	FA		FA	FA	20	0.53	**-0.5**
M12	Economic need (scarcity)	1	S4	Presence of drug traffic																		MS					MA		MA													3	0.08	**0.1**
M15	Self-sufficiency	1	M1	Having the materials for good life		FS	FS			FS	FS					MS	MS	MS				MS		MA	MA	MA		MA		MA					FA		FA	FA		FA		17	0.45	**0.4**
M18	Land pressures	-1	H12	Traditional diet			FS			FS	FS																							FA				FA				5	0.13	**-0.1**
M19	Cost of living	1	M12	Economic need (scarcity)							FS	FS				MS		MS												MA			FA	FA	FA		FA			FA		10	0.26	**0.3**
M2	Being employed	-1	M12	Economic need (scarcity)		FS	FS		FS	FS	FS	FS	FS													MA		MA						FA		FA	FA				FA	13	0.34	**-0.3**
R12	Disinformation	1	H2	Exposure to agrochemicals	FS	FS		FS		FS			FS			MS	MS	MS										MA							FA								10	0.26	**0.3**
R12	Disinformation	1	W9	Low price of crop																								MA				MA										2	0.05	**0.1**
R14	Behaving well towards others	1	R1	Having good social relations	FS	FS	FS	FS	FS		FS	FS			MS		MS	MS		MS		MS	MS	MA	MA	MA	MA		MA	MA		MA		FA								21	0.55	**0.6**
R15	Outside influences	-1	R16	Traditional values		FS	FS	FS	FS	FS	FS							MS			MS	MS						MA	MA	MA			MA	FA	FA	FA	FA		FA				18	0.47	**-0.5**
R15	Outside influences	1	S4	Presence of drug traffic		FS	FS			FS	FS	FS	FS	MS		MS		MS	MS	MS		MS		MA	MA	MA	MA			MA		MA	MA			FA	FA					21	0.55	**0.6**
R16	Traditional values	-1	E7	Environmental degradation	FS	FS				FS	FS			MS	MS		MS		MS	MS	MS		MS	MA	MA		MA	MA	MA	MA			MA	FA	FA	FA	FA	FA	FA	FA			24	0.63	**-0.6**
R16	Traditional values	1	S1	Feeling safe		FS		FS			FS													MA				MA		MA	MA								FA			8	0.21	**0.2**
R16	Traditional values	1	W14	Push to traditional agriculture														MS		MS				MA						MA	MA				FA	FA					FA	8	0.21	**0.2**
R19	Knowing people in communtiy	1	R1	Having good social relations																					MA					MA												2	0.05	**0.1**
R19	Knowing people in communtiy	1	S1	Feeling safe													MS			MS														FA					FA			5	0.13	**0.1**
R21	Family breakdown	1	M12	Economic need (scarcity)		FS	FS	FS					FS																					FA		FA						6	0.16	**0.2**
R21	Family breakdown	1	S6	Presence of crime																															FA		FA	FA					4	0.11	**0.1**
R23	Unoccupied youth	1	S6	Presence of crime						FS																								FA	FA		FA		FA				5	0.13	**0.1**
R24	Community projects	1	R1	Having good social relations	FS					FS	FS				MS		MS				MS	MS												FA			FA		FA	FA		FA	12	0.32	**0.3**
R27	Neighbourhood watch	1	S1	Feeling safe											MS		MS																										2	0.05	**0.1**
R9	Population pressures	1	E7	Environmental degradation														MS	MS										MA			MA					FA						5	0.13	**0.1**
S10	Stolen production	1	M12	Economic need (scarcity)		FS																	MS											FA	FA	FA			FA			6	0.16	**0.2**
S3	Impunity (soft laws)	-1	S1	Feeling safe		FS				FS	FS			MS		MS		MS			MS	MS				MA			MA	MA	MA	MA	MA									14	0.37	**-0.4**
S4	Presence of drug traffic	1	R21	Family breakdown		FS	FS			FS			MS	MS					MS	MS									MA	MA												9	0.24	**0.2**
S4	Presence of drug traffic	1	S6	Presence of crime					FS	FS	FS	FS	FS					MS	MS	MS		MS	MS	MA	MA	MA		MA	MA	MA	MA	MA		FA	FA	FA	FA		FA			23	0.61	**0.6**
S6	Presence of crime	-1	S1	Feeling safe				FS		FS	FS	FS	FS					MS				MS				MA		MA	MA			MA		FA		FA	FA		FA		FA	16	0.42	**-0.4**
W15	Presence of cooperatives	1	W14	Push to traditional agriculture	FS							FS											MS									MA			FA		FA			FA			7	0.18	**0.2**
W21	Presence of intermediaries	1	W18	Sense of unfairness/exploitation										MS	MS	MS		MS					MS		MA	MA	MA	MA		MA	MA	MA		FA	FA		FA		FA			16	0.42	**0.4**
W21	Presence of intermediaries	1	W24	Intensive agriculture	FS	FS		FS		FS	FS		FS	MS	MS		MS	MS	MS	MS			MA	MA		MA	MA	MA		MA							FA				19	0.50	**0.5**
W24	Intensive agriculture	1	E7	Environmental degradation	FS	FS	FS		FS	FS	FS		FS	MS				MS	MS			MS	MA	MA	MA	MA		MA	MA	MA	MA		MA		FA	FA	FA			FA		23	0.61	**0.6**
W24	Intensive agriculture	1	W25	Decline in agricultural productivity	FS						FS								MS	MS															FA		FA	FA				7	0.18	**0.2**
W25	Decline in agricultural productivity	1	W24	Intensive agriculture							FS					MS							MS			MA			MA	MA							FA					7	0.18	**0.2**
W9	Low price of crop	1	M12	Economic need (scarcity)	FS									MS	MS	MS	MS	MS	MS		MS		MS	MA		MA		MA	MA	MA	MA	MA	MA	FA	FA	FA						19	0.50	**0.5**

Table B –12 . Augmented matrix representing human well-being in the Bribri Indigenous Territory (n=38)

		E1	E14	E7	G5	H1	H12	H16	H18	H19	H2	M1	M12	M15	M18	M19	M2	R1	R12	R14	R15	R16	R19	R21	R23	R24	R27	R9	S1	S10	S3	S4	S6	W14	W15	W18	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Distrust on governing body	Feeling healthy	Traditional diet	Traditional medicine	New diseases	Emotional stress	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Land pressures	Cost of living	Being employed	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Knowing people in communtiy	Family breakdown	Unoccupied youth	Community projects	Neighbourhood watch	Population pressures	Feeling safe	Stolen production	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Sense of unfairness/exploitation	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods												0.4																											
E14	Pressure on resources from outside			0.4																																				
E7	Environmental degradation					-0																																		
G5	Distrust on governing body																																				0.1			
H1	Feeling healthy												-0				0.1																							
H12	Traditional diet					0.6			-0																															
H16	Traditional medicine					0.1																																		
H18	New diseases					-0																																		
H19	Emotional stress					-0																																		
H2	Exposure to agrochemicals					-0																																		
M1	Having the materials for good life																																							
M12	Economic need (scarcity)											-1																				0.1								
M15	Self-sufficiency											0.4																												
M18	Land pressures						-0																																	
M19	Cost of living												0.3																											
M2	Being employed												-0																											
R1	Having good social relations																																							
R12	Disinformation										0.3																													0.1
R14	Behaving well towards others																	0.6																						
R15	Outside influences																					-1										0.6								
R16	Traditional values			-1																									0.2					0.2						
R19	Knowing people in communtiy																	0.1											0.1											
R21	Family breakdown												0.2																				0.1							
R23	Unoccupied youth																																0.1							
R24	Community projects																	0.3																						
R27	Neighbourhood watch																												0.1											
R9	Population pressures			0.1																																				
S1	Feeling safe																																							
S10	Stolen production												0.2																											
S3	Impunity (soft laws)																												-0											
S4	Presence of drug traffic																							0.2									0.6							
S6	Presence of crime																												-0											
W14	Push to traditional agriculture																																							
W15	Presence of cooperatives																																	0.2						
W18	Sense of unfairness/exploitation																																							
W21	Presence of intermediaries																																			0.4		0.5		
W24	Intensive agriculture			0.6																																			0.2	
W25	Decline in agricultural productivity																																					0.2		
W9	Low price of crop												0.5																												

Table B – 13. Table of relationships identified by residents in Amubrë (n=19) used to calculate the weights in the augmented matrix (FA stands for females from Amubrë, MA stands for males from Amubrë).

Participants = 19

	Variable	Polarity		Variable	T021	T022	T026	T027	T030	T031	T035	T037	T039	T042	T023	T025	T028	T029	T032	T036	T038	T040	T041	Frequency	Avg. weight	Matrix weights
E1	Floods	1	M12	Economic need (scarcity)		MA			MA			MA				FA	FA	FA	FA				FA	8	0.42	**0.4**
E14	Pressure on resources from outside	1	E7	Environmental degradation			MA			MA			MA	MA		FA	FA	FA	FA	FA				9	0.47	**0.5**
E7	Environmental degradation	-1	H1	Feeling healthy		MA				MA		MA	MA							FA				5	0.26	**-0.3**
G5	Distrust on governing body	1	W21	Presence of intermediaries				MA	MA			MA		MA										4	0.21	**0.2**
H12	Traditional diet	1	H1	Feeling healthy	MA		MA		MA	MA		MA	MA	MA	FA	FA	FA	FA		FA	FA			13	0.68	**0.7**
H12	Traditional diet	-1	H18	New diseases											FA	FA	FA			FA	FA			5	0.26	**-0.3**
H16	Traditional medicine	1	H1	Feeling healthy				MA							FA									2	0.11	**0.1**
H18	New diseases	-1	H1	Feeling healthy											FA	FA	FA			FA	FA			5	0.26	**-0.3**
H19	Emotional stress	-1	H1	Feeling healthy															FA			FA	FA	3	0.16	**-0.2**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	MA	MA			MA		MA	MA		MA		FA					FA			8	0.42	**-0.4**
M12	Economic need (scarcity)	-1	M1	Having the materials for good life	MA	MA	MA		MA	MA	MA			MA	FA	FA	FA	FA	FA	FA		FA	FA	15	0.79	**-0.8**
M12	Economic need (scarcity)	1	S4	Presence of drug traffic				MA		MA														2	0.11	**0.1**
M15	Self-sufficiency	1	M1	Having the materials for good life	MA	MA	MA		MA		MA						FA		FA	FA		FA		9	0.47	**0.5**
M18	Land pressures	-1	H12	Traditional diet												FA				FA				2	0.11	**-0.1**
M19	Cost of living	1	M12	Economic need (scarcity)									MA		FA	FA	FA		FA			FA		6	0.32	**0.3**
M2	Being employed	-1	M12	Economic need (scarcity)			MA		MA						FA		FA	FA					FA	6	0.32	**-0.3**
R12	Disinformation	1	H2	Exposure to agrochemicals					MA							FA								2	0.11	**0.1**
R12	Disinformation	1	W9	Low price of crop					MA					MA										2	0.11	**0.1**
R14	Behaving well towards others	1	R1	Having good social relations	MA	MA	MA	MA		MA	MA		MA		FA									8	0.42	**0.4**
R15	Outside influences	-1	R16	Traditional values				MA	MA	MA				MA	FA	FA	FA	FA		FA				9	0.47	**-0.5**
R15	Outside influences	1	S4	Presence of drug traffic	MA	MA	MA	MA			MA		MA	MA			FA	FA						9	0.47	**0.5**
R16	Traditional values	-1	E7	Environmental degradation	MA	MA		MA	MA	MA	MA			MA	FA	FA	FA	FA	FA	FA	FA			14	0.74	**-0.7**
R16	Traditional values	1	S1	Feeling safe	MA				MA		MA	MA									FA			5	0.26	**0.3**
R16	Traditional values	1	W14	Push to traditional agriculture	MA						MA	MA				FA	FA						FA	6	0.32	**0.3**
R19	Knowing people in communtiy	1	R1	Having good social relations		MA					MA													2	0.11	**0.1**
R19	Knowing people in communtiy	1	S1	Feeling safe											FA					FA			FA	3	0.16	**0.2**
R21	Family breakdown	1	M12	Economic need (scarcity)											FA			FA						2	0.11	**0.1**
R21	Family breakdown	1	S6	Presence of crime												FA		FA		FA	FA			4	0.21	**0.2**
R23	Unoccupied youth	1	S6	Presence of crime											FA	FA		FA		FA				4	0.21	**0.2**
R24	Community projects	1	R1	Having good social relations											FA			FA		FA	FA		FA	5	0.26	**0.3**
R9	Population pressures	1	E7	Environmental degradation						MA			MA						FA					3	0.16	**0.2**
S10	Stolen production	1	M12	Economic need (scarcity)											FA	FA	FA				FA			4	0.21	**0.2**
S3	Impunity (soft laws)	-1	S1	Feeling safe			MA			MA	MA	MA	MA	MA										6	0.32	**-0.3**
S4	Presence of drug traffic	1	R21	Family breakdown						MA	MA													2	0.11	**0.1**
S4	Presence of drug traffic	1	S6	Presence of crime	MA	MA	MA		MA	MA	MA	MA	MA		FA	FA	FA	FA			FA			13	0.68	**0.7**
S6	Presence of crime	-1	S1	Feeling safe			MA		MA	MA				MA		FA		FA	FA		FA		FA	9	0.47	**-0.5**
W15	Presence of cooperatives	1	W14	Push to traditional agriculture									MA				FA		FA			FA		4	0.21	**0.2**
W21	Presence of intermediaries	-1	W14	Push to traditional agriculture						MA														1	0.05	**-0.1**
W21	Presence of intermediaries	1	W18	Sense of unfairness/exploitation			MA	MA	MA	MA		MA	MA	MA		FA	FA		FA		FA			11	0.58	**0.6**
W21	Presence of intermediaries	1	W24	Intensive agriculture	MA	MA			MA	MA	MA		MA						FA					7	0.37	**0.4**
W24	Intensive agriculture	1	E7	Environmental degradation	MA	MA	MA		MA	MA	MA	MA		MA		FA	FA	FA			FA			12	0.63	**0.6**
W24	Intensive agriculture	1	W25	Decline in agricultural productivity												FA		FA	FA					3	0.16	**0.2**
W25	Decline in agricultural productivity	1	W24	Intensive agriculture			MA			MA	MA								FA					4	0.21	**0.2**
W9	Low price of crop	1	M12	Economic need (scarcity)	MA		MA		MA	MA	MA	MA	MA	MA	FA	FA	FA							11	0.58	**0.6**

Table B – 14. Augmented matrix representing human well-being in Amubrë (includes males and females) (n=19)

		E1	E14	E7	G5	H1	H12	H16	H18	H19	H2	M1	M12	M15	M18	M19	M2	R1	R12	R14	R15	R16	R19	R21	R23	R24	R9	S1	S10	S3	S4	S6	W14	W15	W18	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Distrust on governing body	Feeling healthy	Traditional diet	Traditional medicine	New diseases	Emotional stress	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Land pressures	Cost of living	Being employed	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Knowing people in communtiy	Family breakdown	Unoccupied youth	Community projects	Population pressures	Feeling safe	Stolen production	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Sense of unfairness/exploitation	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods												0.4																										
E14	Pressure on resources from outside			0.5																																			
E7	Environmental degradation					-0.3																																	
G5	Distrust on governing body																																			0.2			
H1	Feeling healthy																																						
H12	Traditional diet					0.7			-0.3																														
H16	Traditional medicine					0.1																																	
H18	New diseases					-0.3																																	
H19	Emotional stress					-0.2																																	
H2	Exposure to agrochemicals					-0.4																																	
M1	Having the materials for good life																																						
M12	Economic need (scarcity)											-0.8																			0.1								
M15	Self-sufficiency											0.5																												
M18	Land pressures						-0.1																																	
M19	Cost of living												0.3																											
M2	Being employed												-0.3																											
R1	Having good social relations																																						
R12	Disinformation										0.1																													0.1
R14	Behaving well towards others																	0.4																						
R15	Outside influences																					-0.5									0.5								
R16	Traditional values			-0.7																								0.3					0.3						
R19	Knowing people in communtiy																	0.1										0.2											
R21	Family breakdown												0.1																			0.2							
R23	Unoccupied youth																															0.2							
R24	Community projects																	0.3																					
R9	Population pressures			0.2																																			
S1	Feeling safe																																						
S10	Stolen production												0.2																										
S3	Impunity (soft laws)																											-0.3											
S4	Presence of drug traffic																							0.1								0.7							
S6	Presence of crime																											-0.5											
W14	Push to traditional agriculture																																						
W15	Presence of cooperatives																																0.2						
W18	Sense of unfairness/exploitation																																						
W21	Presence of intermediaries																																-0.1		0.6		0.4		
W24	Intensive agriculture			0.6																																		0.2	
W25	Decline in agricultural productivity																																				0.2		
W9	Low price of crop												0.6																										

Table B – 15. Table of relationships identified by residents in Suretka-Shiroles (n=19) used to calculate the weights in the augmented matrix (FS stands for females from Suretka-Shiroles, MS stands for males from Suretka-Shiroles).

Participants = 19

	Variable	Polarity		Variable	T002	T010	T012	T013	T014	T020	T024	T034	T043	T004	T006	T007	T008	T009	T011	T016	T017	T018	T019	Frequency	Avg. weight	Matrix weights
E1	Floods	1	M12	Economic need (scarcity)			FS						FS			MS	MS		MS			MS	MS	7	0.37	**0.4**
E14	Pressure on resources from outside	1	E7	Environmental degradation				FS	FS	FS	FS	FS				MS			MS					7	0.37	**0.4**
E7	Environmental degradation	-1	H1	Feeling healthy			FS		FS		FS		FS			MS	MS	MS	MS		MS		MS	10	0.53	**-0.5**
G5	Distrust on governing body	1	W21	Presence of intermediaries																			MS	1	0.05	**0.1**
H1	Feeling healthy	-1	M12	Economic need (scarcity)		FS	FS			FS	FS													4	0.21	**-0.2**
H1	Feeling healthy	1	M2	Being employed					FS		FS													2	0.11	**0.1**
H12	Traditional diet	1	H1	Feeling healthy	FS		FS	FS		FS	FS							MS	MS	MS		MS		9	0.47	**0.5**
H16	Traditional medicine	1	H1	Feeling healthy						FS							MS							2	0.11	**0.1**
H18	New diseases	-1	H1	Feeling healthy			FS		FS						MS		MS	MS						5	0.26	**-0.3**
H19	Emotional stress	-1	H1	Feeling healthy		FS	FS	FS				FS												4	0.21	**-0.2**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	FS	FS		FS		FS		FS	FS		MS		MS			MS				9	0.47	**-0.5**
M12	Economic need (scarcity)	-1	M1	Having the materials for good life						FS		FS	FS								MS		MS	5	0.26	**-0.3**
M12	Economic need (scarcity)	1	S4	Presence of drug traffic																		MS		1	0.05	**0.1**
M15	Self-sufficiency	1	M1	Having the materials for good life		FS	FS			FS	FS					MS	MS	MS				MS		8	0.42	**0.4**
M18	Land pressures	-1	H12	Traditional diet			FS			FS	FS													3	0.16	**-0.2**
M19	Cost of living	1	M12	Economic need (scarcity)							FS	FS				MS		MS						4	0.21	**0.2**
M2	Being employed	-1	M12	Economic need (scarcity)		FS	FS		FS	FS	FS	FS	FS											7	0.37	**-0.4**
R12	Disinformation	1	H2	Exposure to agrochemicals	FS	FS		FS		FS			FS			MS	MS	MS						8	0.42	**0.4**
R14	Behaving well towards others	1	R1	Having good social relations	FS	FS	FS	FS	FS		FS	FS			MS		MS	MS		MS		MS	MS	13	0.68	**0.7**
R15	Outside influences	-1	R16	Traditional values		FS	FS	FS	FS	FS	FS							MS			MS	MS		9	0.47	**-0.5**
R15	Outside influences	1	S4	Presence of drug traffic		FS	FS			FS	FS	FS	FS	MS		MS		MS	MS	MS		MS		12	0.63	**0.6**
R16	Traditional values	-1	E7	Environmental degradation	FS	FS				FS	FS				MS	MS		MS		MS	MS	MS		10	0.53	**-0.5**
R16	Traditional values	1	S1	Feeling safe		FS		FS			FS													3	0.16	**0.2**
R16	Traditional values	1	W14	Push to traditional agriculture														MS		MS				2	0.11	**0.1**
R19	Knowing people in communtiy	1	S1	Feeling safe													MS			MS				2	0.11	**0.1**
R21	Family breakdown	1	M12	Economic need (scarcity)		FS	FS	FS					FS											4	0.21	**0.2**
R23	Unoccupied youth	1	S6	Presence of crime						FS														1	0.05	**0.1**
R24	Community projects	1	R1	Having good social relations	FS					FS	FS				MS		MS				MS	MS		7	0.37	**0.4**
R27	Neighbourhood watch	1	S1	Feeling safe											MS		MS							2	0.11	**0.1**
R9	Population pressures	1	E7	Environmental degradation														MS	MS					2	0.11	**0.1**
S10	Stolen production	1	M12	Economic need (scarcity)		FS																	MS	2	0.11	**0.1**
S3	Impunity (soft laws)	-1	S1	Feeling safe		FS				FS	FS			MS		MS		MS			MS	MS		8	0.42	**-0.4**
S4	Presence of drug traffic	1	R21	Family breakdown		FS	FS			FS				MS	MS				MS	MS				7	0.37	**0.4**
S4	Presence of drug traffic	1	S6	Presence of crime					FS	FS	FS	FS	FS					MS	MS	MS		MS	MS	10	0.53	**0.5**
S6	Presence of crime	-1	S1	Feeling safe				FS		FS	FS	FS	FS					MS				MS		7	0.37	**-0.4**
W15	Presence of cooperatives	1	W14	Push to traditional agriculture	FS							FS											MS	3	0.16	**0.2**
W21	Presence of intermediaries	1	W18	Sense of unfairness/exploitation											MS	MS	MS		MS				MS	5	0.26	**0.3**
W21	Presence of intermediaries	1	W24	Intensive agriculture	FS	FS		FS		FS	FS		FS		MS	MS		MS	MS	MS	MS			12	0.63	**0.6**
W24	Intensive agriculture	1	E7	Environmental degradation	FS	FS	FS		FS	FS	FS		FS		MS				MS	MS			MS	11	0.58	**0.6**
W24	Intensive agriculture	1	W25	Decline in agricultural productivity	FS						FS								MS	MS				4	0.21	**0.2**
W25	Decline in agricultural productivity	1	W24	Intensive agriculture							FS					MS							MS	3	0.16	**0.2**
W9	Low price of crop	1	M12	Economic need (scarcity)	FS										MS	MS	MS	MS	MS		MS		MS	8	0.42	**0.4**

Table B – 16. Augmented matrix representing human well-being in Suretka-Shiroles (includes males and females) (n=19)

		E1	E14	E7	G5	H1	H12	H16	H18	H19	H2	M1	M12	M15	M18	M19	M2	R1	R12	R14	R15	R16	R19	R21	R23	R24	R27	R9	S1	S10	S3	S4	S6	W14	W15	W18	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Distrust on governing body	Feeling healthy	Traditional diet	Traditional medicine	New diseases	Emotional stress	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Land pressures	Cost of living	Being employed	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Knowing people in communtiy	Family breakdown	Unoccupied youth	Community projects	Neighbourhood watch	Population pressures	Feeling safe	Stolen production	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Sense of unfairness/exploitation	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods												0.4																												
E14	Pressure on resources from outside			0.4																																				
E7	Environmental degradation					-0.5																																		
G5	Distrust on governing body																																				0.1			
H1	Feeling healthy												-0.2				0.1																								
H12	Traditional diet					0.5																																		
H16	Traditional medicine					0.1																																		
H18	New diseases					-0.3																																		
H19	Emotional stress					-0.2																																		
H2	Exposure to agrochemicals					-0.5																																		
M1	Having the materials for good life																																							
M12	Economic need (scarcity)											-0.3																				0.1								
M15	Self-sufficiency											0.4																												
M18	Land pressures						-0.2																																	
M19	Cost of living												0.2																											
M2	Being employed												-0.4																											
R1	Having good social relations																																							
R12	Disinformation										0.4																													
R14	Behaving well towards others																	0.7																						
R15	Outside influences																					-0.5										0.6								
R16	Traditional values			-0.5																									0.2					0.1						
R19	Knowing people in communtiy																												0.1											
R21	Family breakdown												0.2																											
R23	Unoccupied youth																																0.1							
R24	Community projects																	0.4																						
R27	Neighbourhood watch																												0.1											
R9	Population pressures			0.1																																				
S1	Feeling safe																																							
S10	Stolen production												0.1																											
S3	Impunity (soft laws)																												-0.4											
S4	Presence of drug traffic																							0.4									0.5							
S6	Presence of crime																												-0.4											
W14	Push to traditional agriculture																																							
W15	Presence of cooperatives																																	0.2						
W18	Sense of unfairness/exploitation																																							
W21	Presence of intermediaries																																			0.3		0.6		
W24	Intensive agriculture			0.6																																			0.2	
W25	Decline in agricultural productivity																																					0.2		
W9	Low price of crop												0.4																												

Table B – 17. Table of relationships identified by females in Amubrë used to calculate the weights of their corresponding matrix (n=9)

Participants = 9

	Variable	Polarity		Variable	T023	T025	T028	T029	T032	T036	T038	T040	T041	Frequency	Avg. weight	Matrix weights
E1	Floods	1	M12	Economic need (scarcity)		FA	FA	FA	FA				FA	5	0.56	**0.6**
E14	Pressure on resources from outside	1	E7	Environmental degradation		FA	FA	FA	FA	FA				5	0.56	**0.6**
E7	Environmental degradation	-1	H1	Feeling healthy						FA				1	0.11	**-0.1**
H12	Traditional diet	1	H1	Feeling healthy	FA	FA	FA	FA		FA	FA			6	0.67	**0.7**
H12	Traditional diet	-1	H18	New diseases	FA	FA	FA			FA	FA			5	0.56	**-0.6**
H16	Traditional medicine	1	H1	Feeling healthy	FA									1	0.11	**0.1**
H18	New diseases	-1	H1	Feeling healthy	FA	FA	FA			FA	FA			5	0.56	**-0.6**
H19	Emotional stress	-1	H1	Feeling healthy					FA			FA	FA	3	0.33	**-0.3**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy		FA					FA			2	0.22	**-0.2**
M12	Economic need (scarcity)	-1	M1	Having the materials for good life	FA	FA	FA	FA	FA	FA		FA	FA	8	0.89	**-0.9**
M15	Self-sufficiency	1	M1	Having the materials for good life			FA		FA	FA		FA		4	0.44	**0.4**
M18	Land pressures	-1	H12	Traditional diet		FA				FA				2	0.22	**-0.2**
M19	Cost of living	1	M12	Economic need (scarcity)	FA	FA	FA		FA			FA		5	0.56	**0.6**
M2	Being employed	-1	M12	Economic need (scarcity)	FA		FA	FA					FA	4	0.44	**-0.4**
R12	Disinformation	1	H2	Exposure to agrochemicals		FA								1	0.11	**0.1**
R14	Behaving well towards others	1	R1	Having good social relations	FA									1	0.11	**0.1**
R15	Outside influences	-1	R16	Traditional values	FA	FA	FA	FA		FA				5	0.56	**-0.6**
R15	Outside influences	1	S4	Presence of drug traffic			FA	FA						2	0.22	**0.2**
R16	Traditional values	-1	E7	Environmental degradation	FA	FA	FA	FA	FA	FA	FA			7	0.78	**-0.8**
R16	Traditional values	1	S1	Feeling safe							FA			1	0.11	**0.1**
R16	Traditional values	1	W14	Push to traditional agriculture		FA	FA						FA	3	0.33	**0.3**
R19	Knowing people in communtiy	1	S1	Feeling safe	FA					FA			FA	3	0.33	**0.3**
R21	Family breakdown	1	M12	Economic need (scarcity)	FA			FA						2	0.22	**0.2**
R21	Family breakdown	1	S6	Presence of crime		FA		FA		FA	FA			4	0.44	**0.4**
R23	Unoccupied youth	1	S6	Presence of crime	FA	FA		FA		FA				4	0.44	**0.4**
R24	Community projects	1	R1	Having good social relations	FA			FA		FA	FA		FA	5	0.56	**0.6**
R9	Population pressures	1	E7	Environmental degradation					FA					1	0.11	**0.1**
S10	Stolen production	1	M12	Economic need (scarcity)	FA	FA	FA				FA			4	0.44	**0.4**
S4	Presence of drug traffic	1	S6	Presence of crime	FA	FA	FA	FA			FA			5	0.56	**0.6**
S6	Presence of crime	-1	S1	Feeling safe		FA		FA	FA		FA		FA	5	0.56	**-0.6**
W15	Presence of cooperatives	1	W14	Push to traditional agriculture			FA		FA			FA		3	0.33	**0.3**
W21	Presence of intermediaries	1	W18	Sense of unfairness/exploitation		FA	FA		FA		FA			4	0.44	**0.4**
W21	Presence of intermediaries	1	W24	Intensive agriculture					FA					1	0.11	**0.1**
W24	Intensive agriculture	1	E7	Environmental degradation		FA	FA	FA			FA			4	0.44	**0.4**
W24	Intensive agriculture	1	W25	Decline in agricultural productivity		FA		FA	FA					3	0.33	**0.3**
W25	Decline in agricultural productivity	1	W24	Intensive agriculture					FA					1	0.11	**0.1**
W9	Low price of crop	1	M12	Economic need (scarcity)	FA	FA	FA							3	0.33	**0.3**

Table B – 18. Matrix of human well-being from the perspective of females in Amubrë (n=9)

		E1	E14	E7	H1	H12	H16	H18	H19	H2	M1	M12	M15	M18	M19	M2	R1	R12	R14	R15	R16	R19	R21	R23	R24	R9	S1	S10	S4	S6	W14	W15	W18	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Feeling healthy	Traditional diet	Traditional medicine	New diseases	Emotional stress	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Land pressures	Cost of living	Being employed	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Knowing people in communtiy	Family breakdown	Unoccupied youth	Community projects	Population pressures	Feeling safe	Stolen production	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Sense of unfairness/exploitation	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods											0.6																									
E14	Pressure on resources from outside			0.6																																	
E7	Environmental degradation				-0.1																																
H1	Feeling healthy																																				
H12	Traditional diet				0.7			-0.6																													
H16	Traditional medicine				0.1																																
H18	New diseases				-0.6																																
H19	Emotional stress				-0.3																																
H2	Exposure to agrochemicals				-0.2																																
M1	Having the materials for good life																																				
M12	Economic need (scarcity)										-0.9																										
M15	Self-sufficiency										0.4																										
M18	Land pressures					-0.2																															
M19	Cost of living											0.6																									
M2	Being employed											-0.4																									
R1	Having good social relations																																				
R12	Disinformation									0.1																											
R14	Behaving well towards others																0.1																				
R15	Outside influences																				-0.6								0.2								
R16	Traditional values			-0.8																							0.1			0.3							
R19	Knowing people in communtiy																										0.3										
R21	Family breakdown											0.2																		0.4								
R23	Unoccupied youth																													0.4								
R24	Community projects																0.6																				
R9	Population pressures			0.1																																	
S1	Feeling safe																																				
S10	Stolen production											0.4																									
S4	Presence of drug traffic																													0.6							
S6	Presence of crime																										-0.6										
W14	Push to traditional agriculture																																				
W15	Presence of cooperatives																													0.3							
W18	Sense of unfairness/exploitation																																				
W21	Presence of intermediaries																																0.4		0.1		
W24	Intensive agriculture			0.4																																0.3	
W25	Decline in agricultural productivity																																		0.1		
W9	Low price of crop											0.3																									

Table B – 19. Table of relationships identified by males in Amubrë used to calculate the weights of their corresponding matrix (n=9)

Participants = 9

	Variable	Polarity		Variable	T022	T026	T027	T030	T031	T035	T037	T039	T042	Frequency	Avg. weight	Matrix weights
E1	Floods	1	M12	Economic need (scarcity)	MA			MA			MA			3	0.33	**0.3**
E14	Pressure on resources from outside	1	E7	Environmental degradation		MA			MA			MA	MA	4	0.44	**0.4**
E7	Environmental degradation	-1	H1	Feeling healthy	MA				MA		MA	MA		4	0.44	**-0.4**
G5	Distrust on governing body	1	W21	Presence of intermediaries			MA	MA			MA		MA	4	0.44	**0.4**
H12	Traditional diet	1	H1	Feeling healthy		MA		MA	MA		MA	MA	MA	6	0.67	**0.7**
H16	Traditional medicine	1	H1	Feeling healthy			MA							1	0.11	**0.1**
H2	Exposure to agrochemicals	-1	H1	Feeling healthy	MA			MA		MA	MA		MA	5	0.56	**-0.6**
M12	Economic need (scarcity)	-1	M1	Having the materials for good life	MA	MA		MA	MA	MA			MA	6	0.67	**-0.7**
M12	Economic need (scarcity)	1	S4	Presence of drug traffic			MA		MA					2	0.22	**0.2**
M15	Self-sufficiency	1	M1	Having the materials for good life	MA	MA		MA		MA				4	0.44	**0.4**
M19	Cost of living	1	M12	Economic need (scarcity)								MA		1	0.11	**0.1**
M2	Being employed	-1	M12	Economic need (scarcity)		MA		MA						2	0.22	**-0.2**
R12	Disinformation	1	H2	Exposure to agrochemicals				MA						1	0.11	**0.1**
R12	Disinformation	1	W9	Low price of crop				MA					MA	2	0.22	**0.2**
R14	Behaving well towards others	1	R1	Having good social relations	MA	MA	MA		MA	MA		MA		6	0.67	**0.7**
R15	Outside influences	-1	R16	Traditional values			MA	MA	MA				MA	4	0.44	**-0.4**
R15	Outside influences	1	S4	Presence of drug traffic	MA	MA	MA			MA		MA	MA	6	0.67	**0.7**
R16	Traditional values	-1	E7	Environmental degradation	MA		MA	MA	MA	MA			MA	6	0.67	**-0.7**
R16	Traditional values	1	S1	Feeling safe				MA		MA	MA			3	0.33	**0.3**
R16	Traditional values	1	W14	Push to traditional agriculture						MA	MA			2	0.22	**0.2**
R19	Knowing people in communtiy	1	R1	Having good social relations	MA					MA				2	0.22	**0.2**
R9	Population pressures	1	E7	Environmental degradation					MA			MA		2	0.22	**0.2**
S3	Impunity (soft laws)	-1	S1	Feeling safe		MA			MA	MA	MA	MA	MA	6	0.67	**-0.7**
S4	Presence of drug traffic	1	R21	Family breakdown					MA	MA				2	0.22	**0.2**
S4	Presence of drug traffic	1	S6	Presence of crime	MA	MA		MA	MA	MA	MA	MA		7	0.78	**0.8**
S6	Presence of crime	-1	S1	Feeling safe		MA		MA	MA				MA	4	0.44	**-0.4**
W15	Presence of cooperatives	1	W14	Push to traditional agriculture								MA		1	0.11	**0.1**
W21	Presence of intermediaries	1	W18	Sense of unfairness/exploitation		MA	MA	MA	MA		MA	MA	MA	7	0.78	**0.8**
W21	Presence of intermediaries	1	W24	Intensive agriculture	MA			MA	MA	MA		MA		5	0.56	**0.6**
W24	Intensive agriculture	1	E7	Environmental degradation	MA	MA		MA	MA	MA	MA		MA	7	0.78	**0.8**
W25	Decline in agricultural productivity	1	W24	Intensive agriculture		MA			MA	MA				3	0.33	**0.3**
W9	Low price of crop	1	M12	Economic need (scarcity)		MA		MA	MA	MA	MA	MA	MA	7	0.78	**0.8**

Table B – 20. Matrix of human well-being from the perspective of males in Amubrë (n=9)

		E1	E14	E7	G5	H1	H12	H16	H2	M1	M12	M15	M19	M2	R1	R12	R14	R15	R16	R19	R21	R9	S1	S3	S4	S6	W14	W15	W18	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Distrust on governing body	Feeling healthy	Traditional diet	Traditional medicine	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Cost of living	Being employed	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Knowing people in communtiy	Family breakdown	Population pressures	Feeling safe	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Sense of unfairness/exploitation	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods										0.3																						
E14	Pressure on resources from outside			0.4																													
E7	Environmental degradation					-0.4																											
G5	Distrust on governing body																													0.4			
H1	Feeling healthy																																
H12	Traditional diet					0.7																											
H16	Traditional medicine					0.1																											
H2	Exposure to agrochemicals					-0.6																											
M1	Having the materials for good life																																
M12	Economic need (scarcity)									-0.7															0.2								
M15	Self-sufficiency									0.4																							
M19	Cost of living										0.1																						
M2	Being employed										-0.2																						
R1	Having good social relations																																
R12	Disinformation								0.1																								0.2
R14	Behaving well towards others														0.7																		
R15	Outside influences																		-0.4						0.7								
R16	Traditional values			-0.7																			0.3				0.2						
R19	Knowing people in communtiy														0.2																		
R21	Family breakdown																																
R9	Population pressures			0.2																													
S1	Feeling safe																																
S3	Impunity (soft laws)																						-0.7										
S4	Presence of drug traffic																				0.2					0.8							
S6	Presence of crime																						-0.4										
W14	Push to traditional agriculture																																
W15	Presence of cooperatives																										0.1						
W18	Sense of unfairness/exploitation																																
W21	Presence of intermediaries																												0.8		0.6		
W24	Intensive agriculture			0.8																													
W25	Decline in agricultural productivity																														0.3		
W9	Low price of crop										0.8																						

Table B – 21. Table of relationships identified by females in Suretka-Shiroles used to calculate the weights of their corresponding matrix (n=9)

	Participants	=	9													
	Variable	**Polarity**		**Variable**	**T002**	**T010**	**T012**	**T013**	**T014**	**T020**	**T024**	**T034**	**T043**	Frequency	Avg. weight	**Matrix weights**
E1	Floods	**1**	M12	Economic need (scarcity)			FS						FS	2	0.22	**0.2**
E14	Pressure on resources from outside	**1**	E7	Environmental degradation				FS	FS	FS	FS	FS		5	0.56	**0.6**
E7	Environmental degradation	**-1**	H1	Feeling healthy			FS		FS		FS		FS	4	0.44	**-0.4**
H1	Feeling healthy	**-1**	M12	Economic need (scarcity)		FS	FS			FS	FS			4	0.44	**-0.4**
H1	Feeling healthy	**1**	M2	Being employed					FS		FS			2	0.22	**0.2**
H12	Traditional diet	**1**	H1	Feeling healthy	FS		FS	FS		FS	FS			5	0.56	**0.6**
H16	Traditional medicine	**1**	H1	Feeling healthy						FS				1	0.11	**0.1**
H18	New diseases	**-1**	H1	Feeling healthy			FS		FS					2	0.22	**-0.2**
H19	Emotional stress	**-1**	H1	Feeling healthy		FS	FS	FS				FS		4	0.44	**-0.4**
H2	Exposure to agrochemicals	**-1**	H1	Feeling healthy	FS	FS		FS		FS		FS	FS	6	0.67	**-0.7**
M12	Economic need (scarcity)	**-1**	M1	Having the materials for good life						FS		FS	FS	3	0.33	**-0.3**
M15	Self-sufficiency	**1**	M1	Having the materials for good life		FS	FS			FS	FS			4	0.44	**0.4**
M18	Land pressures	**-1**	H12	Traditional diet			FS			FS	FS			3	0.33	**-0.3**
M19	Cost of living	**1**	M12	Economic need (scarcity)							FS	FS		2	0.22	**0.2**
M2	Being employed	**-1**	M12	Economic need (scarcity)		FS	FS		FS	FS	FS	FS	FS	7	0.78	**-0.8**
R12	Disinformation	**1**	H2	Exposure to agrochemicals	FS	FS		FS		FS			FS	5	0.56	**0.6**
R14	Behaving well towards others	**1**	R1	Having good social relations	FS	FS	FS	FS	FS		FS	FS		7	0.78	**0.8**
R15	Outside influences	**-1**	R16	Traditional values		FS	FS	FS	FS	FS	FS			6	0.67	**-0.7**
R15	Outside influences	**1**	S4	Presence of drug traffic		FS	FS			FS	FS	FS	FS	6	0.67	**0.7**
R16	Traditional values	**-1**	E7	Environmental degradation	FS	FS				FS	FS			4	0.44	**-0.4**
R16	Traditional values	**1**	S1	Feeling safe		FS		FS			FS			3	0.33	**0.3**
R21	Family breakdown	**1**	M12	Economic need (scarcity)		FS	FS	FS					FS	4	0.44	**0.4**
R23	Unoccupied youth	**1**	S6	Presence of crime						FS				1	0.11	**0.1**
R24	Community projects	**1**	R1	Having good social relations	FS					FS	FS			3	0.33	**0.3**
S10	Stolen production	**1**	M12	Economic need (scarcity)		FS								1	0.11	**0.1**
S3	Impunity (soft laws)	**-1**	S1	Feeling safe		FS				FS	FS			3	0.33	**-0.3**
S4	Presence of drug traffic	**1**	R21	Family breakdown		FS	FS			FS				3	0.33	**0.3**
S4	Presence of drug traffic	**1**	S6	Presence of crime					FS	FS	FS	FS	FS	5	0.56	**0.6**
S6	Presence of crime	**-1**	S1	Feeling safe				FS		FS	FS	FS	FS	5	0.56	**-0.6**
W15	Presence of cooperatives	**1**	W14	Push to traditional agriculture	FS							FS		2	0.22	**0.2**
W21	Presence of intermediaries	**1**	W24	Intensive agriculture	FS	FS		FS		FS	FS		FS	6	0.67	**0.7**
W24	Intensive agriculture	**1**	E7	Environmental degradation	FS	FS	FS		FS	FS	FS		FS	7	0.78	**0.8**
W24	Intensive agriculture	**1**	W25	Decline in agricultural productivity	FS						FS			2	0.22	**0.2**
W25	Decline in agricultural productivity	**1**	W24	Intensive agriculture							FS			1	0.11	**0.1**
W9	Low price of crop	**1**	M12	Economic need (scarcity)	FS									1	0.11	**0.1**

Table B – 22. Matrix of human well-being from the perspective of females in Suretka-Shiroles (n=9)

		E1	E14	E7	H1	H12	H16	H18	H19	H2	M1	M12	M15	M18	M19	M2	R1	R12	R14	R15	R16	R21	R23	R24	S1	S10	S3	S4	S6	W14	W15	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Feeling healthy	Traditional diet	Traditional medicine	New diseases	Emotional stress	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Land pressures	Cost of living	Being employed	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Family breakdown	Unoccupied youth	Community projects	Feeling safe	Stolen production	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods											0.2																							
E14	Pressure on resources from outside			0.6																															
E7	Environmental degradation				-0.4																														
H1	Feeling healthy											-0.4				0.2																			
H12	Traditional diet				0.6																														
H16	Traditional medicine				0.1																														
H18	New diseases				-0.2																														
H19	Emotional stress				-0.4																														
H2	Exposure to agrochemicals				-0.7																														
M1	Having the materials for good life																																		
M12	Economic need (scarcity)										-0.3																								
M15	Self-sufficiency										0.4																								
M18	Land pressures					-0.3																													
M19	Cost of living											0.2																							
M2	Being employed											-0.8																							
R1	Having good social relations																																		
R12	Disinformation									0.6																									
R14	Behaving well towards others																0.8																		
R15	Outside influences																				-0.7							0.7							
R16	Traditional values			-0.4																					0.3										
R21	Family breakdown											0.4																							
R23	Unoccupied youth																												0.1						
R24	Community projects																0.3																		
S1	Feeling safe																																		
S10	Stolen production											0.1																							
S3	Impunity (soft laws)																								-0.3										
S4	Presence of drug traffic																					0.3							0.6						
S6	Presence of crime																								-0.6										
W14	Push to traditional agriculture																																		
W15	Presence of cooperatives																													0.2					
W21	Presence of intermediaries																																0.7		
W24	Intensive agriculture			0.8																														0.2	
W25	Decline in agricultural productivity																																0.1		
W9	Low price of crop															0.1																			

Table B –23. Table of relationships identified by males in Suretka-Shiroles used to calculate the weights of their corresponding matrix (n=10)

	Participants	=	10														
	Variable	**Polarity**		**Variable**	**T004**	**T006**	**T007**	**T008**	**T009**	**T011**	**T016**	**T017**	**T018**	**T019**	Frequency	Avg. weight	**Matrix weights**
E1	Floods	**1**	M12	Economic need (scarcity)			MS	MS		MS			MS	MS	5	0.50	**0.5**
E14	Pressure on resources from outside	**1**	E7	Environmental degradation			MS			MS					2	0.20	**0.2**
E7	Environmental degradation	**-1**	H1	Feeling healthy			MS	MS	MS	MS		MS		MS	6	0.60	**-0.6**
G5	Distrust on governing body	**1**	W21	Presence of intermediaries										MS	1	0.10	**0.1**
H12	Traditional diet	**1**	H1	Feeling healthy					MS	MS	MS		MS		4	0.40	**0.4**
H16	Traditional medicine	**1**	H1	Feeling healthy				MS							1	0.10	**0.1**
H18	New diseases	**-1**	H1	Feeling healthy		MS		MS	MS						3	0.30	**-0.3**
H2	Exposure to agrochemicals	**-1**	H1	Feeling healthy		MS		MS			MS				3	0.30	**-0.3**
M12	Economic need (scarcity)	**-1**	M1	Having the materials for good life								MS		MS	2	0.20	**-0.2**
M12	Economic need (scarcity)	**1**	S4	Presence of drug traffic									MS		1	0.10	**0.1**
M15	Self-sufficiency	**1**	M1	Having the materials for good life			MS	MS	MS				MS		4	0.40	**0.4**
M19	Cost of living	**1**	M12	Economic need (scarcity)			MS		MS						2	0.20	**0.2**
R12	Disinformation	**1**	H2	Exposure to agrochemicals			MS	MS	MS						3	0.30	**0.3**
R14	Behaving well towards others	**1**	R1	Having good social relations		MS		MS	MS		MS		MS	MS	6	0.60	**0.6**
R15	Outside influences	**-1**	R16	Traditional values					MS			MS	MS		3	0.30	**-0.3**
R15	Outside influences	**1**	S4	Presence of drug traffic	MS		MS		MS	MS	MS		MS		6	0.60	**0.6**
R16	Traditional values	**-1**	E7	Environmental degradation		MS	MS		MS		MS	MS	MS		6	0.60	**-0.6**
R16	Traditional values	**1**	W14	Push to traditional agriculture					MS		MS				2	0.20	**0.2**
R19	Knowing people in communtiy	**1**	S1	Feeling safe				MS			MS				2	0.20	**0.2**
R24	Community projects	**1**	R1	Having good social relations		MS		MS				MS	MS		4	0.40	**0.4**
R27	Neighbourhood watch	**1**	S1	Feeling safe		MS		MS							2	0.20	**0.2**
R9	Population pressures	**1**	E7	Environmental degradation					MS	MS					2	0.20	**0.2**
S10	Stolen production	**1**	M12	Economic need (scarcity)										MS	1	0.10	**0.1**
S3	Impunity (soft laws)	**-1**	S1	Feeling safe	MS		MS		MS			MS	MS		5	0.50	**-0.5**
S4	Presence of drug traffic	**1**	R21	Family breakdown	MS	MS				MS	MS				4	0.40	**0.4**
S4	Presence of drug traffic	**1**	S6	Presence of crime					MS	MS	MS		MS	MS	5	0.50	**0.5**
S6	Presence of crime	**-1**	S1	Feeling safe					MS				MS		2	0.20	**-0.2**
W15	Presence of cooperatives	**1**	W14	Push to traditional agriculture										MS	1	0.10	**0.1**
W21	Presence of intermediaries	**1**	W18	Sense of unfairness/exploitation		MS	MS	MS		MS				MS	5	0.50	**0.5**
W21	Presence of intermediaries	**1**	W24	Intensive agriculture		MS	MS		MS	MS	MS	MS			6	0.60	**0.6**
W24	Intensive agriculture	**1**	E7	Environmental degradation		MS				MS	MS			MS	4	0.40	**0.4**
W24	Intensive agriculture	**1**	W25	Decline in agricultural productivity						MS	MS				2	0.20	**0.2**
W25	Decline in agricultural productivity	**1**	W24	Intensive agriculture			MS							MS	2	0.20	**0.2**
W9	Low price of crop	**1**	M12	Economic need (scarcity)		MS	MS	MS	MS	MS		MS		MS	7	0.70	**0.7**

Table B – 24. Matrix of human well-being from the perspective of males in Suretka-Shiroles (n=10)

		E1	E14	E7	G5	H1	H12	H16	H18	H2	M1	M12	M15	M19	R1	R12	R14	R15	R16	R19	R21	R24	R27	R9	S1	S10	S3	S4	S6	W14	W15	W18	W21	W24	W25	W9
		Floods	Pressure on resources from outside	Environmental degradation	Distrust on governing body	Feeling healthy	Traditional diet	Traditional medicine	New diseases	Exposure to agrochemicals	Having the materials for good life	Economic need (scarcity)	Self-sufficiency	Cost of living	Having good social relations	Disinformation	Behaving well towards others	Outside influences	Traditional values	Knowing people in communtiy	Family breakdown	Community projects	Neighbourhood watch	Population pressures	Feeling safe	Stolen production	Impunity (soft laws)	Presence of drug traffic	Presence of crime	Push to traditional agriculture	Presence of cooperatives	Sense of unfairness/exploitation	Presence of intermediaries	Intensive agriculture	Decline in agricultural productivity	Low price of crop
E1	Floods											0.5																								
E14	Pressure on resources from outside			0.2																																
E7	Environmental degradation	-0.6																																		
G5	Distrust on governing body																																0.1			
H1	Feeling healthy																																			
H12	Traditional diet					0.4																														
H16	Traditional medicine					0.1																														
H18	New diseases					-0.3																														
H2	Exposure to agrochemicals					-0.3																														
M1	Having the materials for good life																																			
M12	Economic need (scarcity)										-0.2																	0.1								
M15	Self-sufficiency										0.4																										
M19	Cost of living											0.2																									
R1	Having good social relations																																			
R12	Disinformation									0.3																										
R14	Behaving well towards others														0.6																					
R15	Outside influences																		-0.3									0.6								
R16	Traditional values			-0.6																										0.2						
R19	Knowing people in communtiy																								0.2											
R21	Family breakdown																																			
R24	Community projects														0.4																					
R27	Neighbourhood watch																								0.2											
R9	Population pressures			0.2																																
S1	Feeling safe																																			
S10	Stolen production											0.1																								
S3	Impunity (soft laws)																								-0.5											
S4	Presence of drug traffic																				0.4								0.5							
S6	Presence of crime																								-0.2											
W14	Push to traditional agriculture																																			
W15	Presence of cooperatives																													0.1						
W18	Sense of unfairness/exploitation																																			
W21	Presence of intermediaries																															0.5		0.6		
W24	Intensive agriculture			0.4																															0.2	
W25	Decline in agricultural productivity																																	0.2		
W9	Low price of crop											0.7																								

APPENDIX C

MATINA FEMALE HOUSEWIVES

Figure C-1. *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Female Housewives In Matina (n=6). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

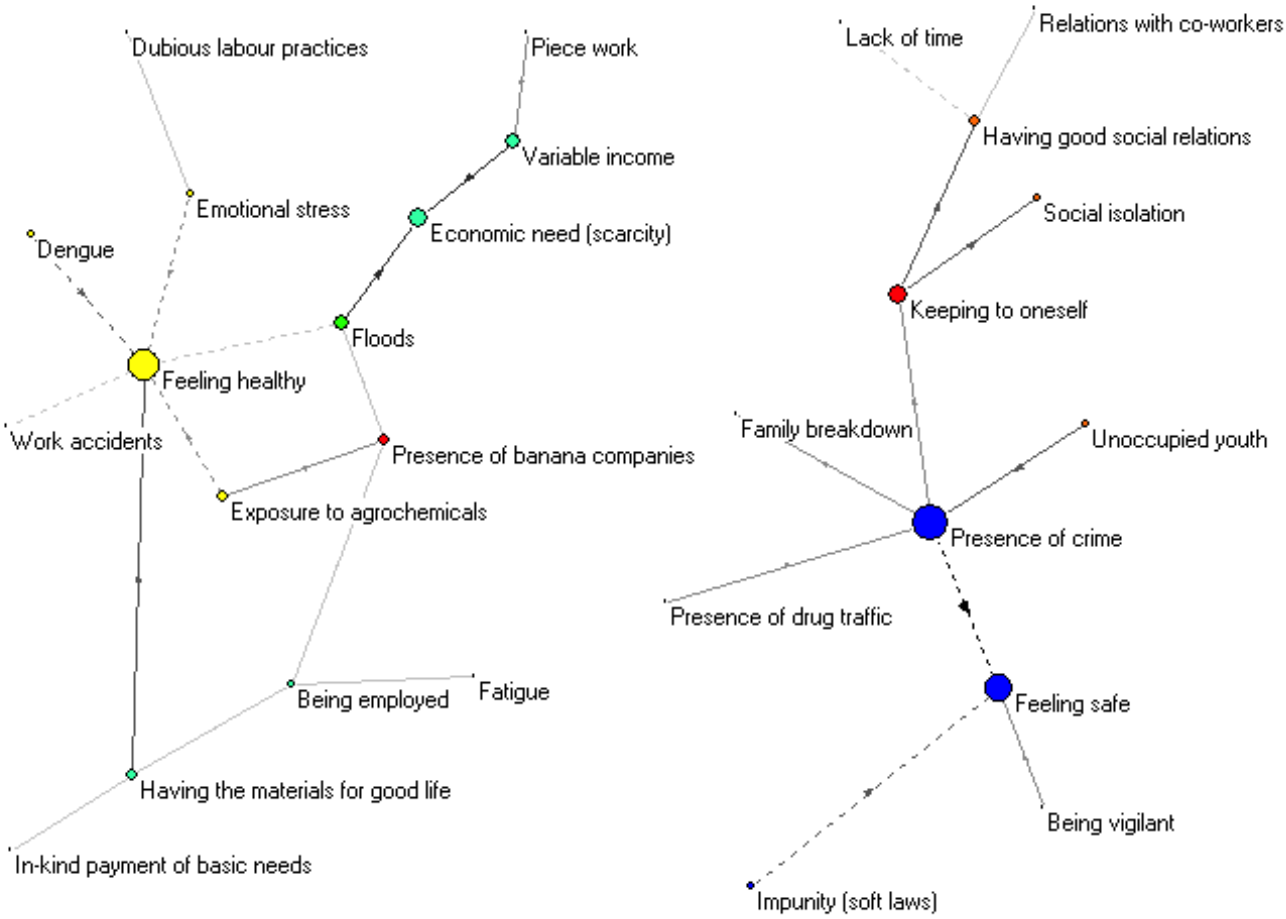


Figure C-2 - *Centrality Index For Factors Affecting The Well-being Of Female Housewives In Matina (n=6)*

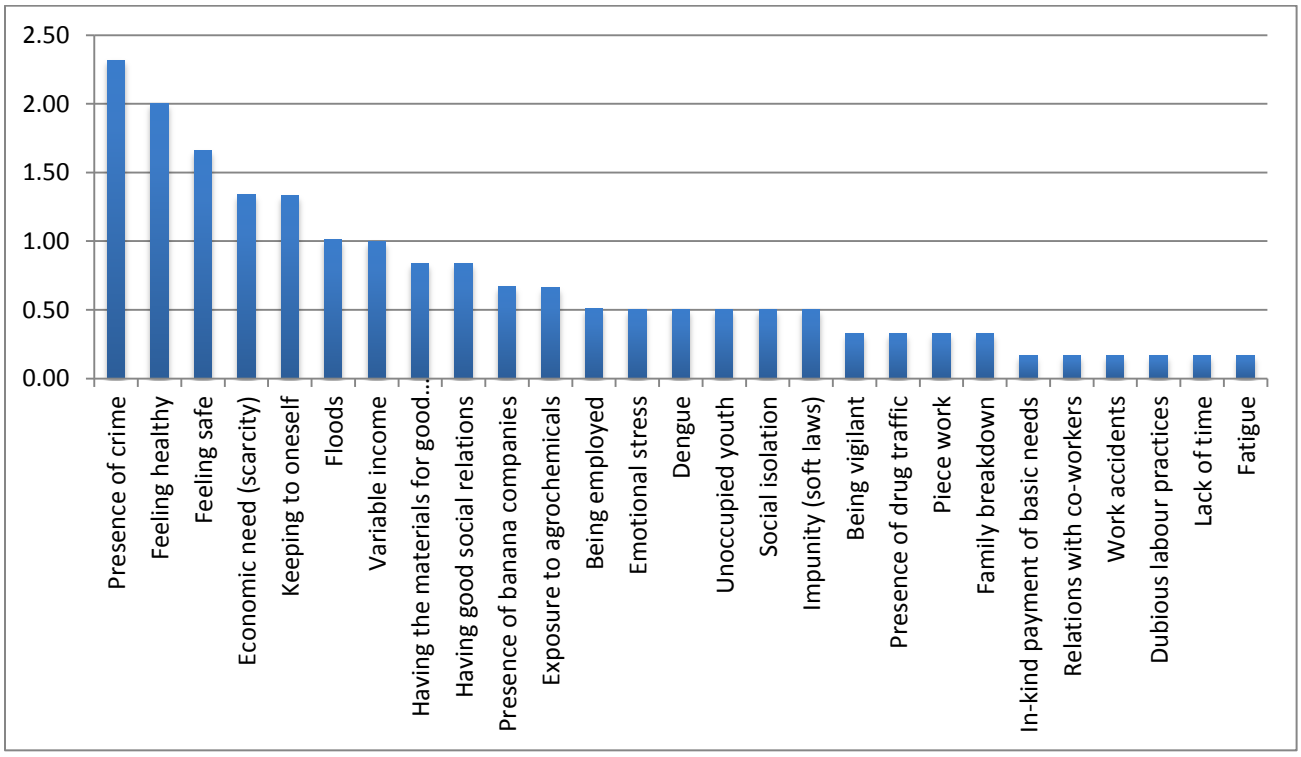


Figure C-3 - *Indegree Index For Factors Affecting The Well-being Of Female Housewives In Matina (n=6)*

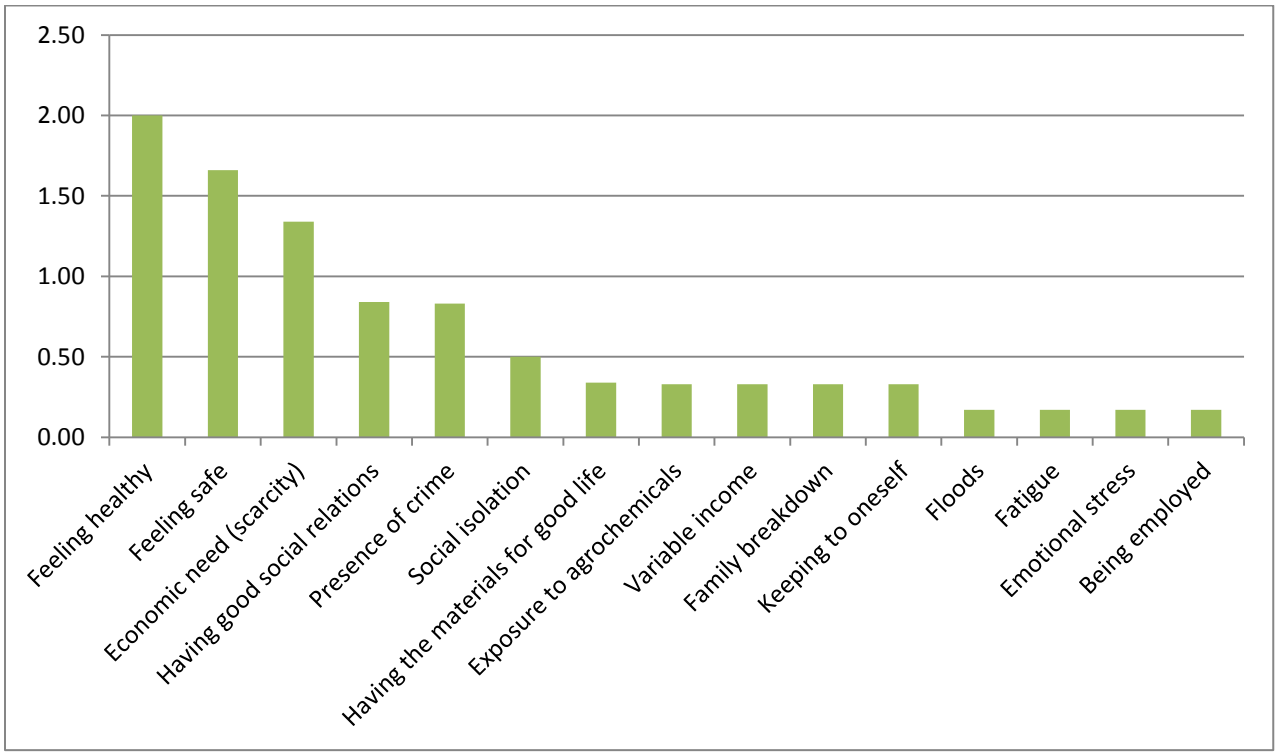


Figure C-4 - *Outdegree Index For Factors Affecting The Well-being Of Female Housewives In Matina (n=6)*

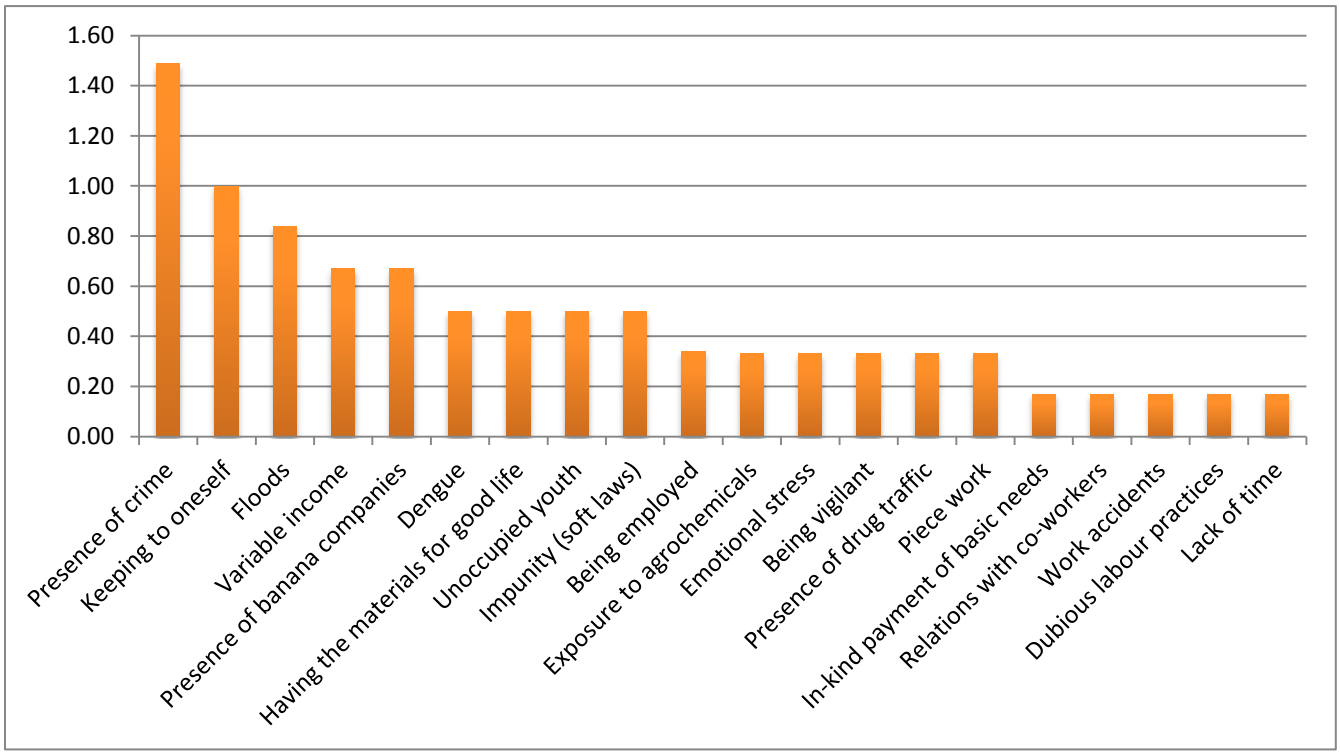


Table C-1 – *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Female Housewives In Matina (n=6)*

Factor	Centrality	Outdegree	Indegree
Being employed	0.51	0.34	0.17
Being vigilant	0.33	0.33	0.00
Dengue	0.50	0.50	0.00
Dubious labour practices	0.17	0.17	0.00
Economic need (scarcity)	1.34	0.00	1.34
Emotional stress	0.50	0.33	0.17
Exposure to agrochemicals	0.66	0.33	0.33
Family breakdown	0.33	0.00	0.33
Fatigue	0.17	0.00	0.17
Feeling healthy	2.00	0.00	2.00
Feeling safe	1.66	0.00	1.66
Floods	1.01	0.84	0.17
Having good social relations	0.84	0.00	0.84
Having the materials for good life	0.84	0.50	0.34
Impunity (soft laws)	0.50	0.50	0.00
In-kind payment of basic needs	0.17	0.17	0.00
Keeping to oneself	1.33	1.00	0.33

Lack of time	0.17	0.17	0.00
Piece work	0.33	0.33	0.00
Presence of banana companies	0.67	0.67	0.00
Presence of crime	2.32	1.49	0.83
Presence of drug traffic	0.33	0.33	0.00
Relations with co-workers	0.17	0.17	0.00
Social isolation	0.50	0.00	0.50
Unoccupied youth	0.50	0.50	0.00
Variable income	1.00	0.67	0.33
Work accidents	0.17	0.17	0.00

MATINA FEMALE PLANTATION WORKERS

Figure C-5 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Female Plantation Workers In Matina (n=8). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

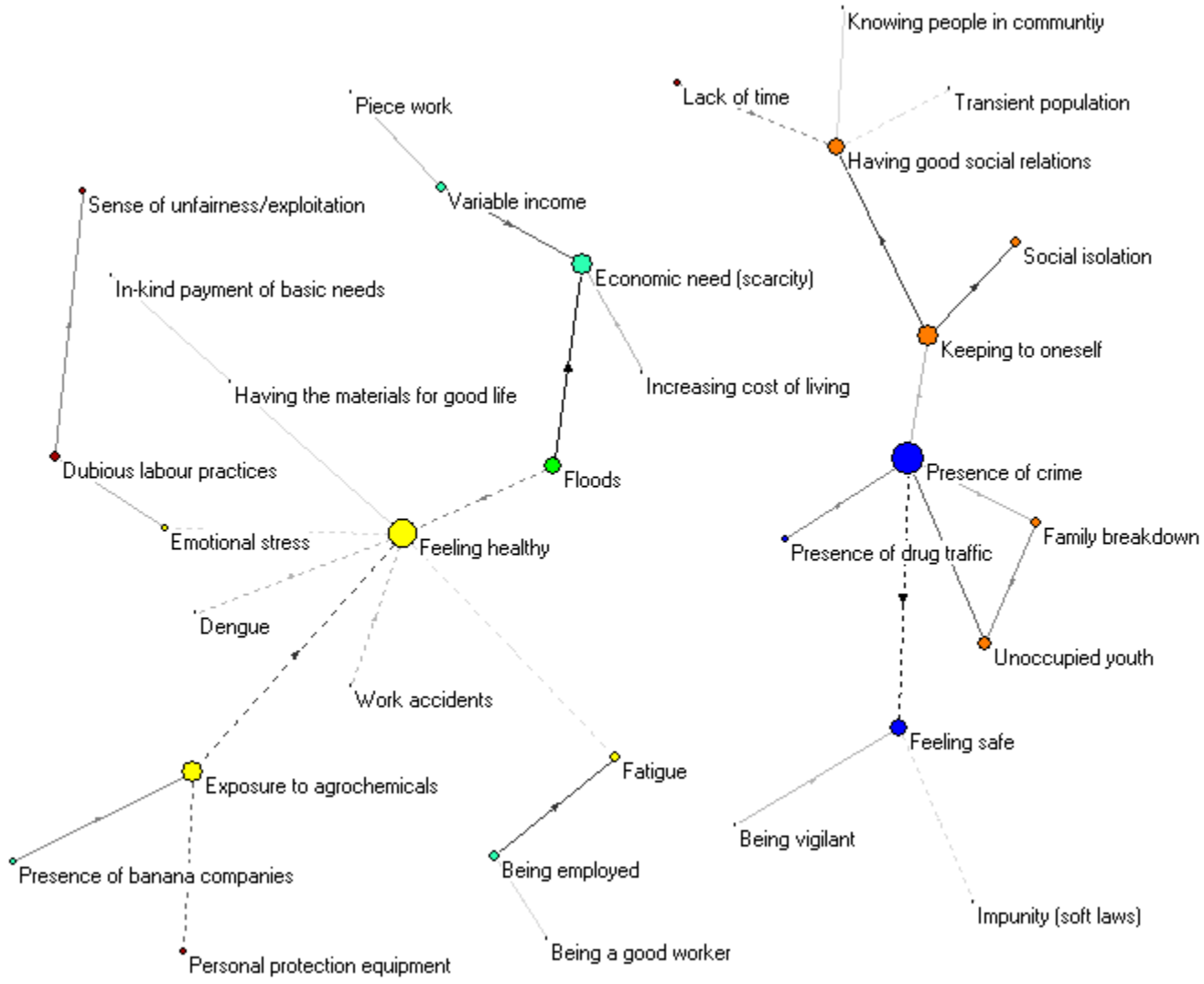


Figure C-6 - *Centrality Index For Factors Affecting The Well-being Of Female Plantation Workers In Matina (n=8)*

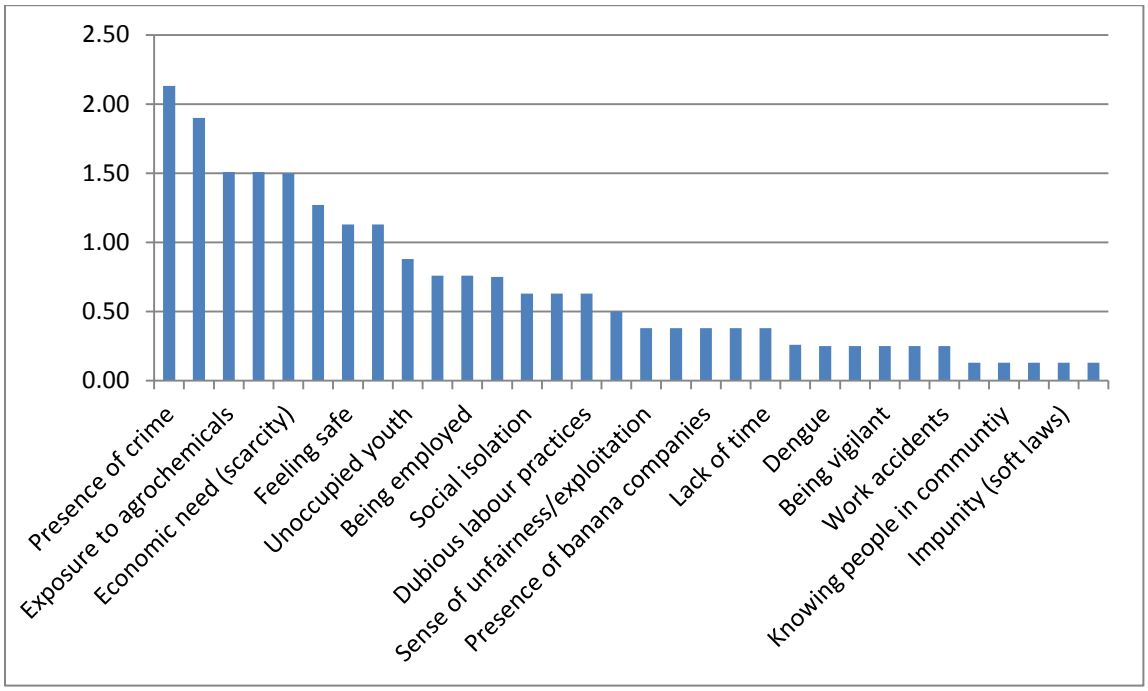


Figure C-7 - *Indegree Index For Factors Affecting The Well-being Of Female Plantation Workers In Matina (n=8)*

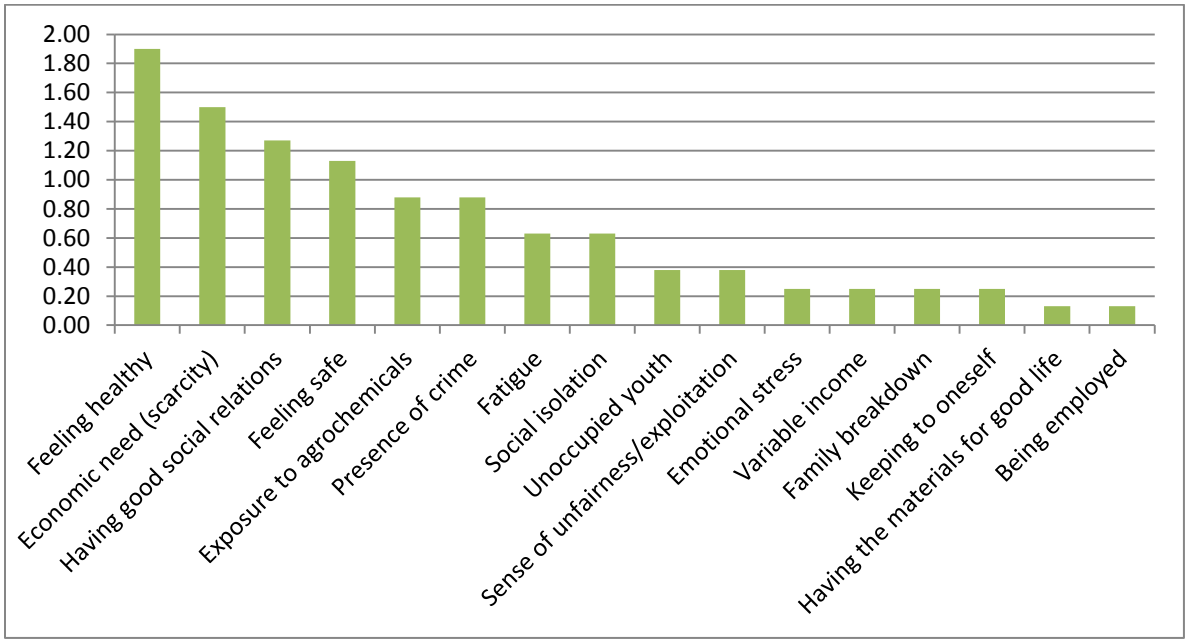


Figure C-8 - *Outdegree Index For Factors Affecting The Well-being Of Female Plantation Workers In Matina (n=8)*

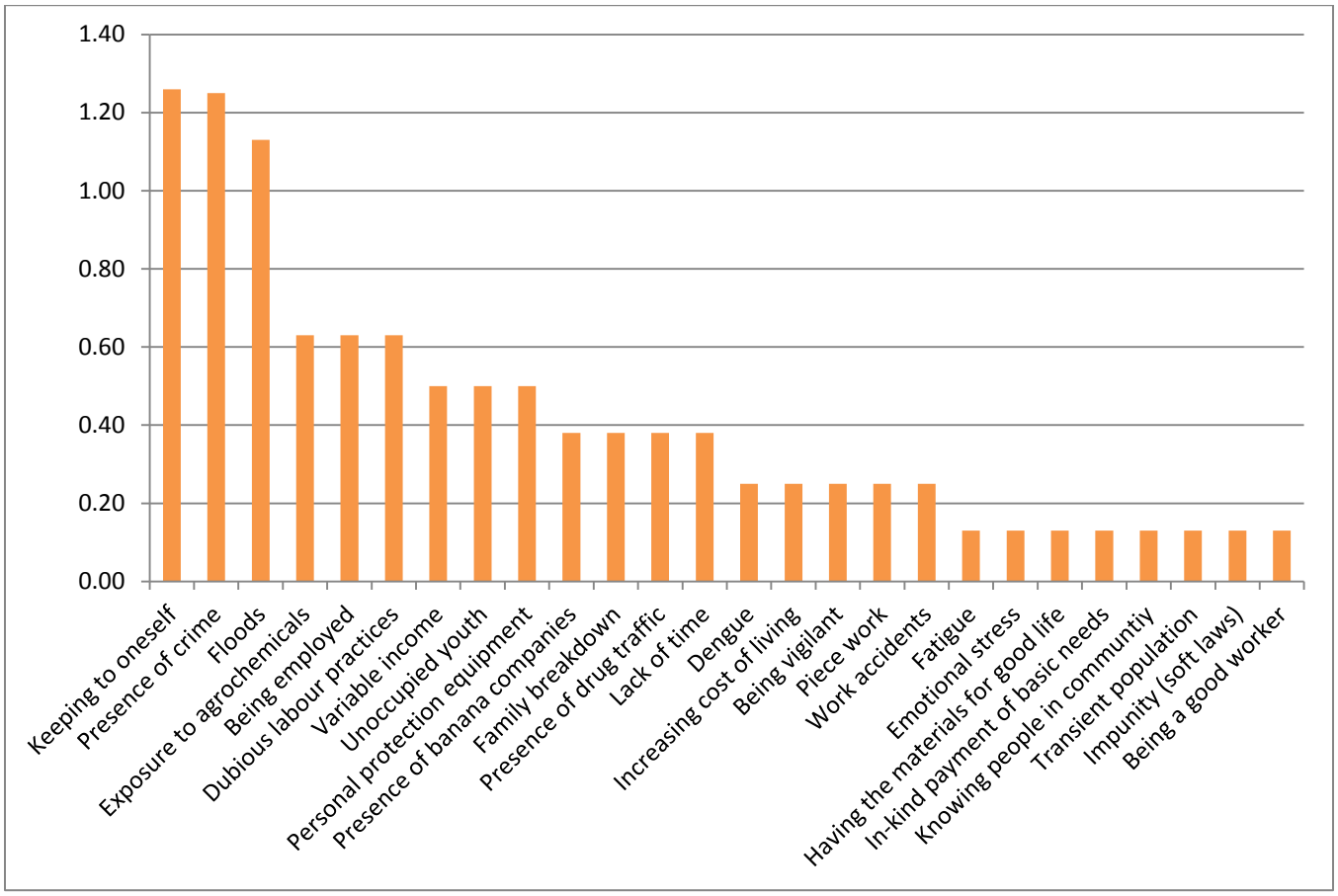


Table C-2 - *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Female Plantation Workers In Matina (n=8)*

Concepts	Centrality	Outdegree	Indegree
Being a good worker	0.13	0.13	0.00
Being employed	0.76	0.63	0.13
Being vigilant	0.25	0.25	0.00
Dengue	0.25	0.25	0.00
Dubious labour practices	0.63	0.63	0.00
Economic need (scarcity)	1.50	0.00	1.50
Emotional stress	0.38	0.13	0.25
Exposure to agrochemicals	1.51	0.63	0.88
Family breakdown	0.63	0.38	0.25
Fatigue	0.76	0.13	0.63
Feeling healthy	1.90	0.00	1.90
Feeling safe	1.13	0.00	1.13
Floods	1.13	1.13	0.00
Having good social relations	1.27	0.00	1.27
Having the materials for good life	0.26	0.13	0.13
Impunity (soft laws)	0.13	0.13	0.00
Increasing cost of living	0.25	0.25	0.00
In-kind payment of basic needs	0.13	0.13	0.00
Keeping to oneself	1.51	1.26	0.25
Knowing people in community	0.13	0.13	0.00
Lack of time	0.38	0.38	0.00
Personal protection equipment	0.50	0.50	0.00
Piece work	0.25	0.25	0.00
Presence of banana companies	0.38	0.38	0.00
Presence of crime	2.13	1.25	0.88
Presence of drug traffic	0.38	0.38	0.00
Sense of unfairness/exploitation	0.38	0.00	0.38
Social isolation	0.63	0.00	0.63
Transient population	0.13	0.13	0.00
Unoccupied youth	0.88	0.50	0.38
Variable income	0.75	0.50	0.25
Work accidents	0.25	0.25	0.00

Figure C-9 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Costa Rican Male Plantation Workers In Matina (n-8). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

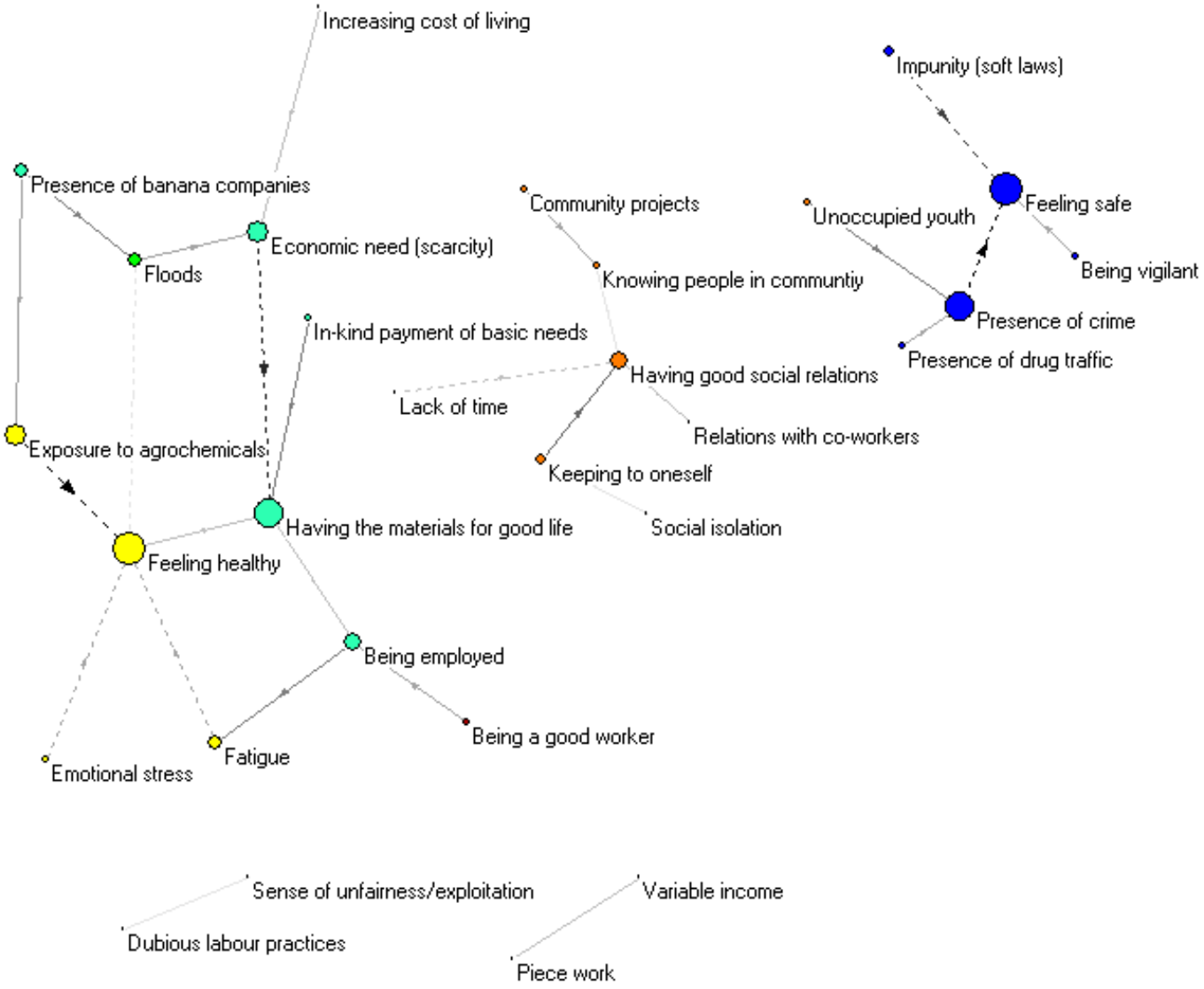


Figure C-10 - *Centrality Index For Factors Affecting The Well-being Of Costa Rican Male Plantation Workers In Matina (n=8)*

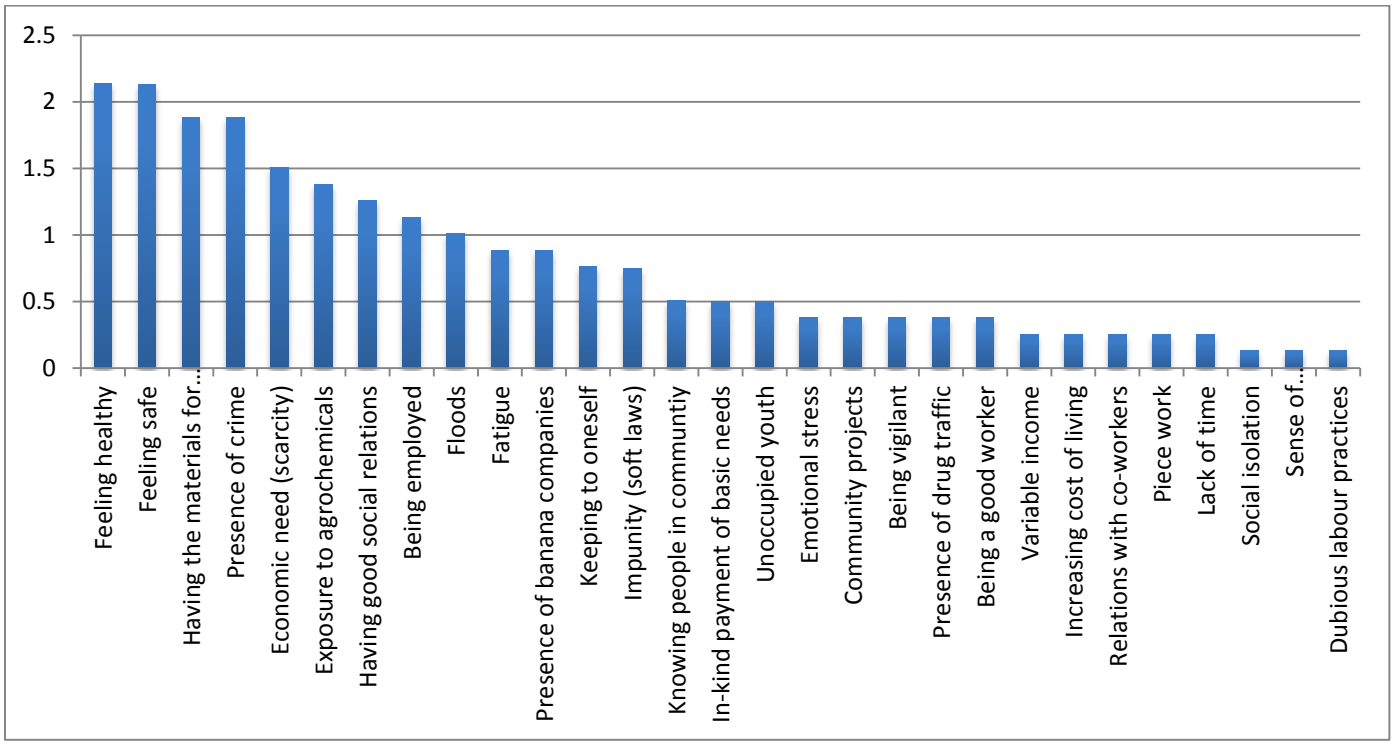


Figure C-11 - *Indegree Index For Factors Affecting The Well-being Of Costa Rican Male Plantation Workers In Matina (n=8)*

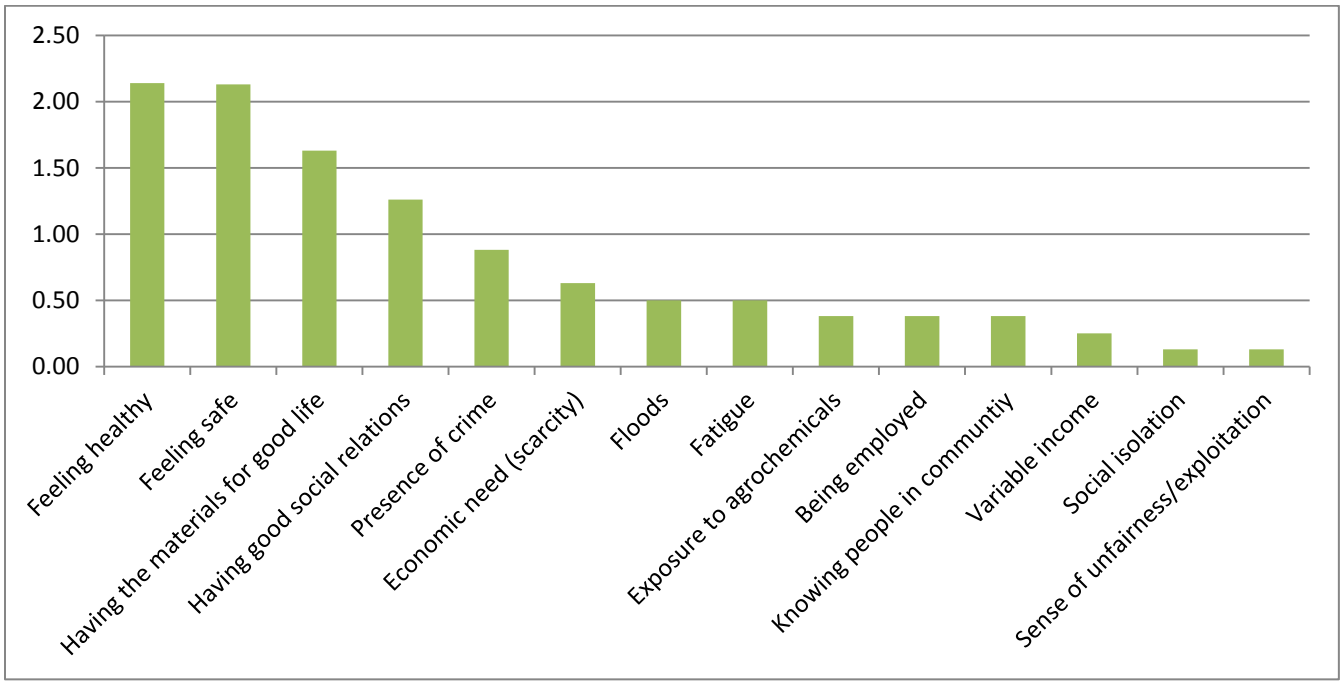


Figure C-12- *Outdegree Index For Factors Affecting The Well-being Of Costa Rican Male Plantation Workers In Matina (n=8)*

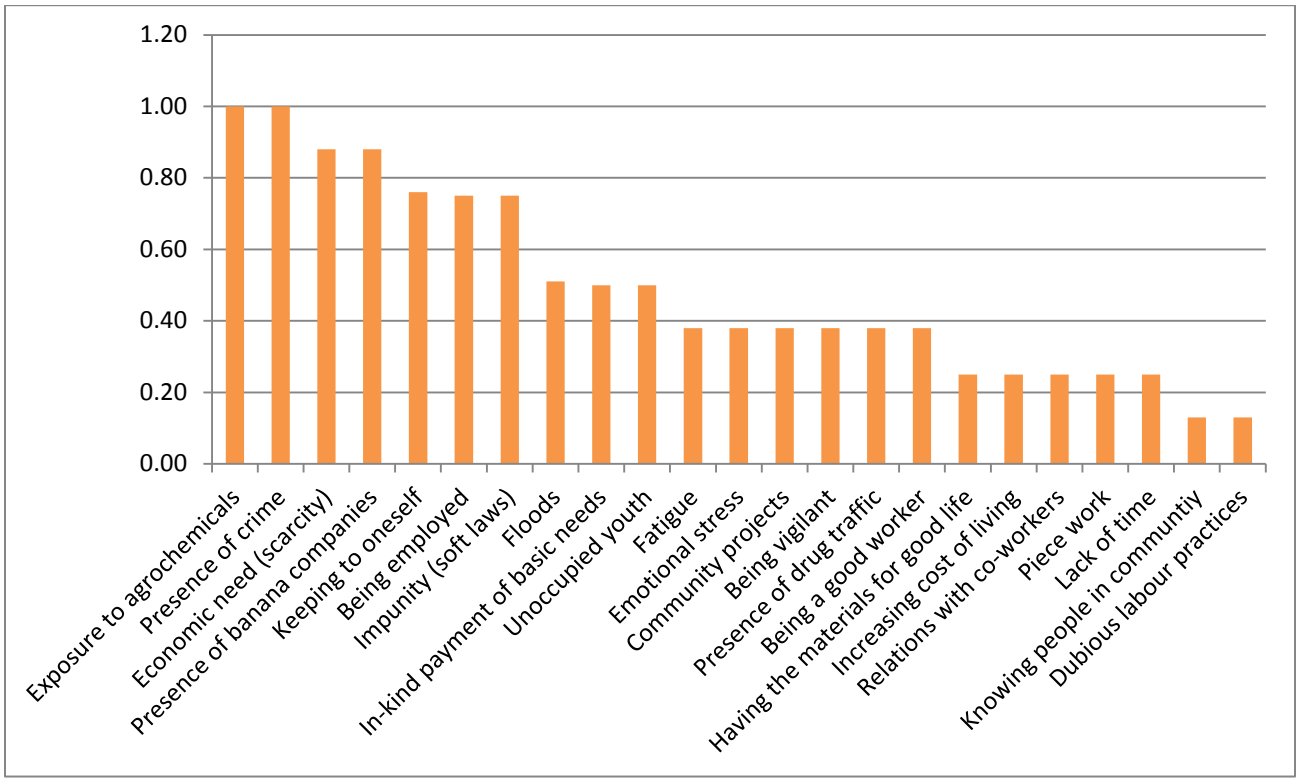


Table C-3 *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Costa Rican Male Plantation Workers In Matina (n=8)*

Concepts	Centrality	Outdegree	Indegree
Being a good worker	0.38	0.38	0.00
Being employed	1.13	0.75	0.38
Being vigilant	0.38	0.38	0.00
Community projects	0.38	0.38	0.00
Dubious labour practices	0.13	0.13	0.00
Economic need (scarcity)	1.51	0.88	0.63
Emotional stress	0.38	0.38	0.00
Exposure to agrochemicals	1.38	1.00	0.38
Fatigue	0.88	0.38	0.50
Feeling healthy	2.14	0.00	2.14
Feeling safe	2.13	0.00	2.13
Floods	1.01	0.51	0.50
Having good social relations	1.26	0.00	1.26
Having the materials for good life	1.88	0.25	1.63
Impunity (soft laws)	0.75	0.75	0.00
Increasing cost of living	0.25	0.25	0.00
In-kind payment of basic needs	0.50	0.50	0.00
Keeping to oneself	0.76	0.76	0.00
Knowing people in communtiy	0.51	0.13	0.38
Lack of time	0.25	0.25	0.00
Piece work	0.25	0.25	0.00
Presence of banana companies	0.88	0.88	0.00
Presence of crime	1.88	1.00	0.88
Presence of drug traffic	0.38	0.38	0.00
Relations with co-workers	0.25	0.25	0.00
Sense of unfairness/exploitation	0.13	0.00	0.13
Social isolation	0.13	0.00	0.13
Unoccupied youth	0.50	0.50	0.00
Variable income	0.25	0.00	0.25

Figure C-13 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Nicaraguan Male Plantation Workers In Matina (n=7). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

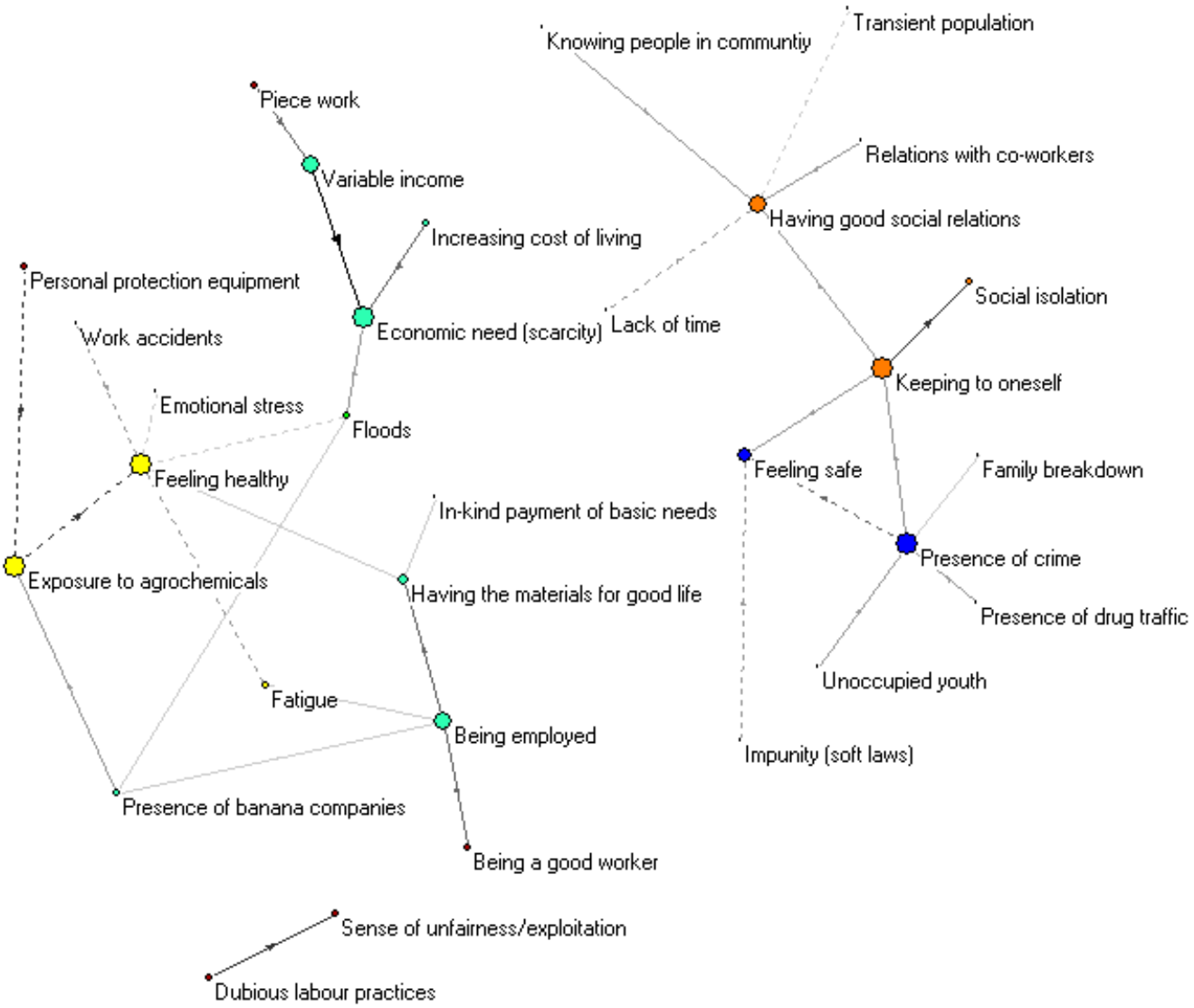


Figure C-14 - *Centrality Index For Factors Affecting The Well-being Of Nicaraguan Male Plantation Workers In Matina (n=7)*

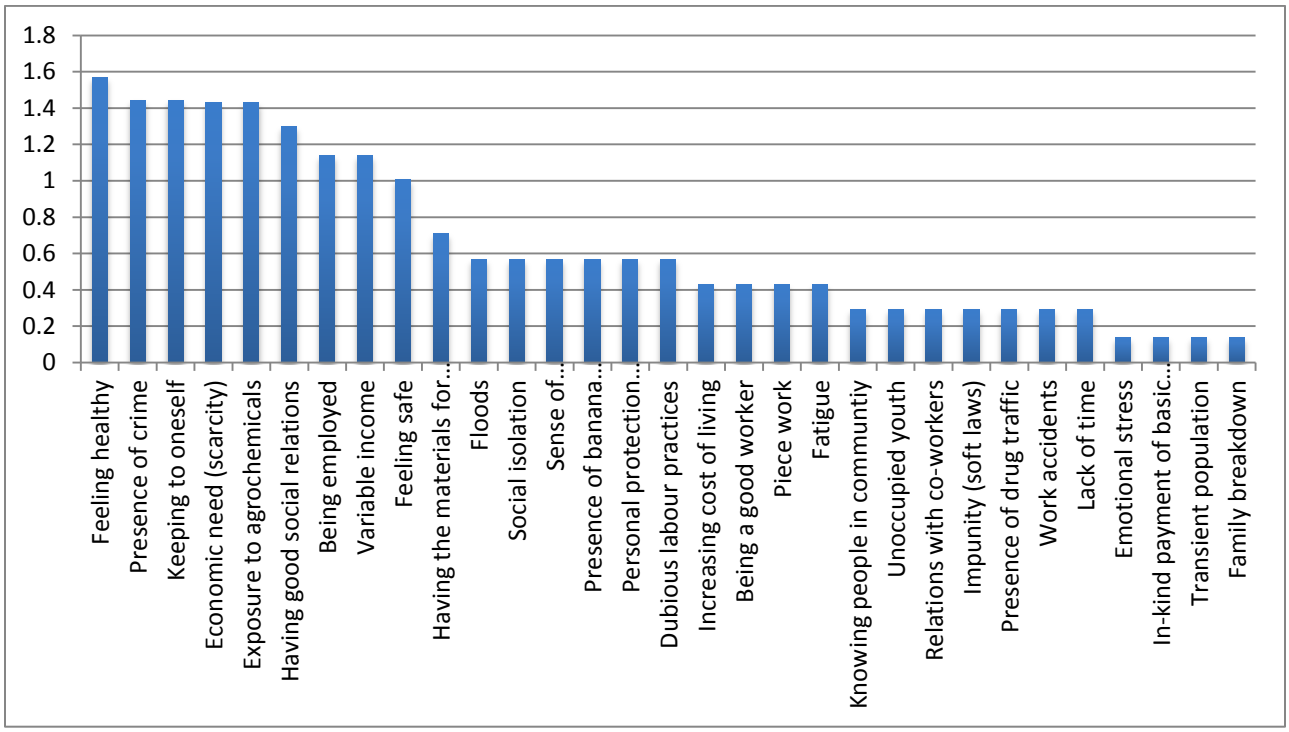


Figure C-15- *Indegree Index For Factors Affecting The Well-being Of Nicaraguan Male Plantation Workers In Matina (n=7)*

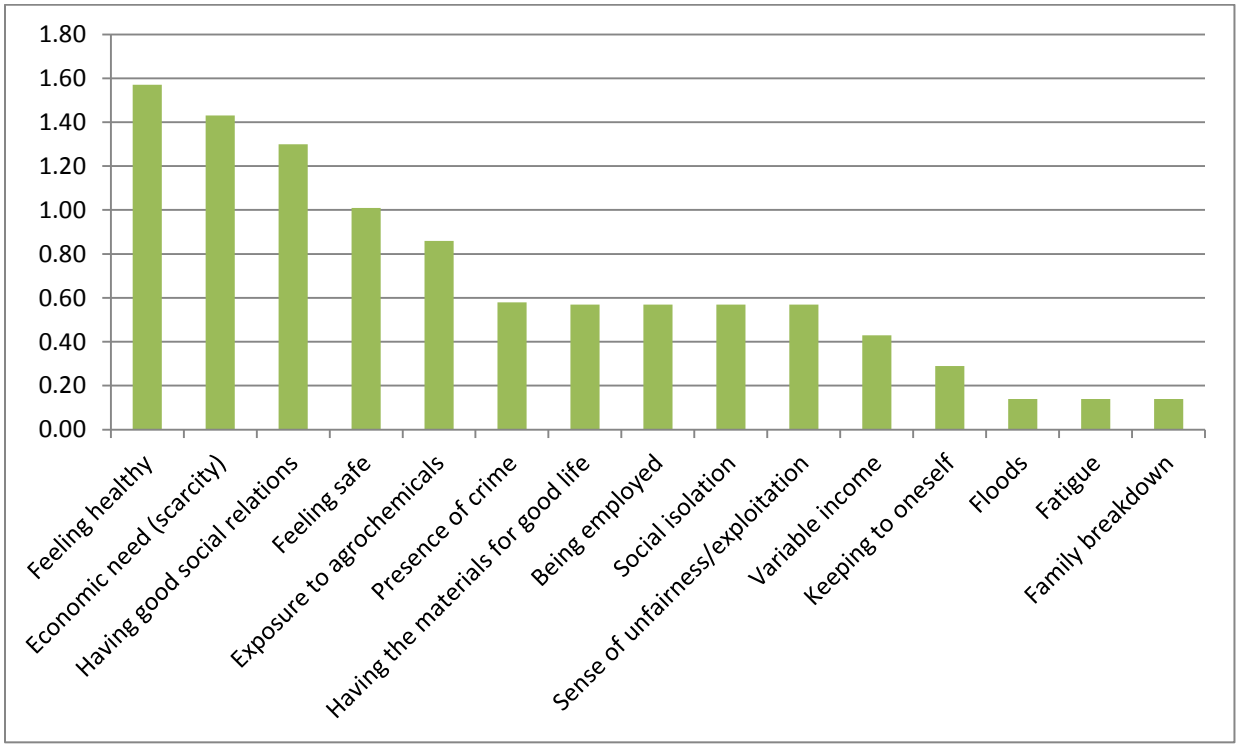


Figure C-16 - *Outdegree Index For Factors Affecting The Well-being Of Nicaraguan Male Plantation Workers In Matina (n=7)*

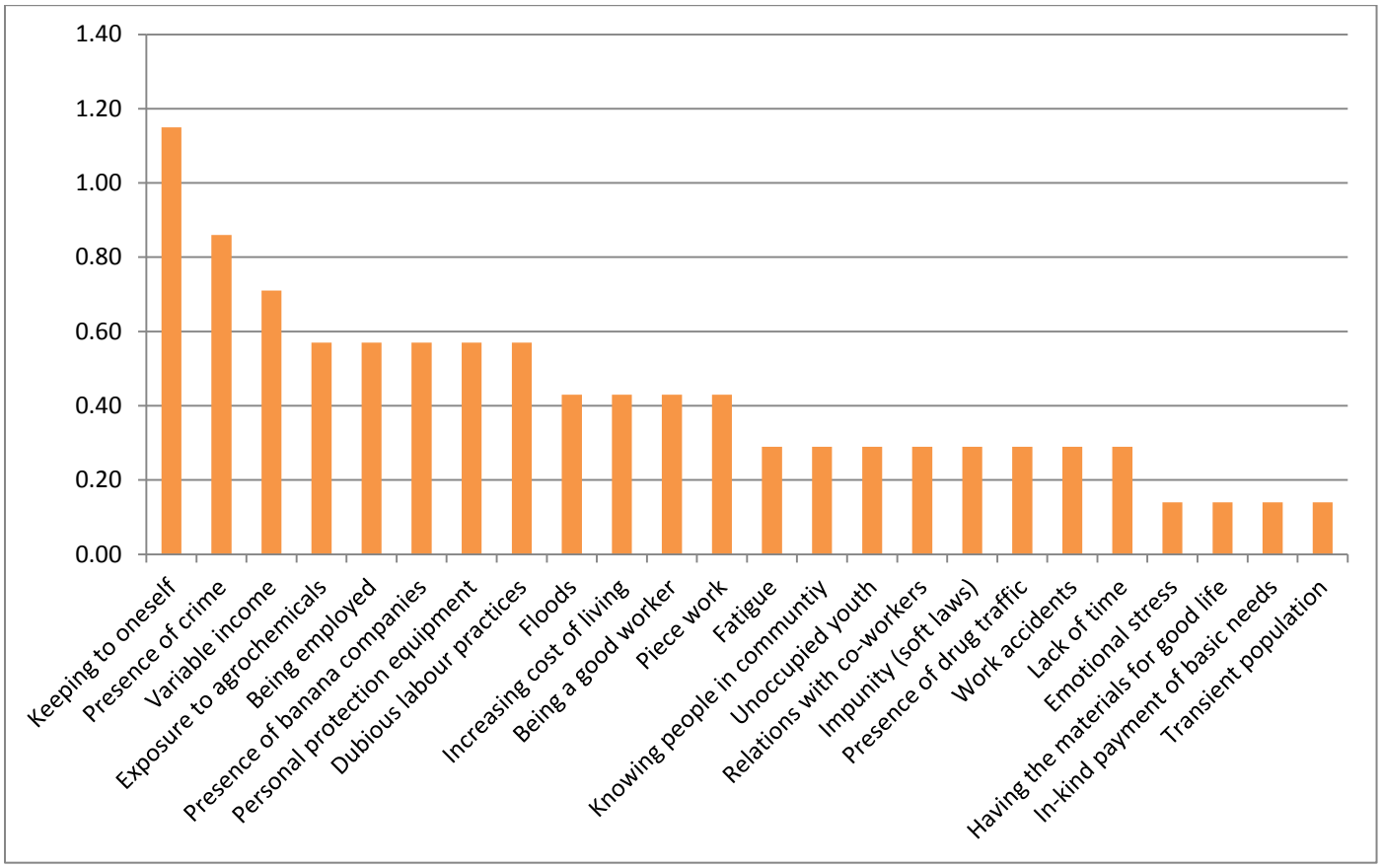


Table C-4 - *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Nicaraguan Male Plantation Workers In Matina (n=7)*

Concepts	Centrality	Outdegree	Indegree
Being a good worker	0.43	0.43	0.00
Being employed	1.14	0.57	0.57
Dubious labour practices	0.57	0.57	0.00
Economic need (scarcity)	1.43	0.00	1.43
Emotional stress	0.14	0.14	0.00
Exposure to agrochemicals	1.43	0.57	0.86
Family breakdown	0.14	0.00	0.14
Fatigue	0.43	0.29	0.14
Feeling healthy	1.57	0.00	1.57
Feeling safe	1.01	0.00	1.01
Floods	0.57	0.43	0.14
Having good social relations	1.30	0.00	1.30
Having the materials for good life	0.71	0.14	0.57
Impunity (soft laws)	0.29	0.29	0.00
Increasing cost of living	0.43	0.43	0.00
In-kind payment of basic needs	0.14	0.14	0.00
Keeping to oneself	1.44	1.15	0.29
Knowing people in community	0.29	0.29	0.00
Lack of time	0.29	0.29	0.00
Personal protection equipment	0.57	0.57	0.00
Piece work	0.43	0.43	0.00
Presence of banana companies	0.57	0.57	0.00
Presence of crime	1.44	0.86	0.58
Presence of drug traffic	0.29	0.29	0.00
Relations with co-workers	0.29	0.29	0.00
Sense of unfairness/exploitation	0.57	0.00	0.57
Social isolation	0.57	0.00	0.57
Transient population	0.14	0.14	0.00
Unoccupied youth	0.29	0.29	0.00
Variable income	1.14	0.71	0.43
Work accidents	0.29	0.29	0.00

BRIBRI INDIGENOUS TERRITORY FEMALES FROM SURETKA-SHIROLES

Figure C-17 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Females in Suretka-Shiroles (n=9). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

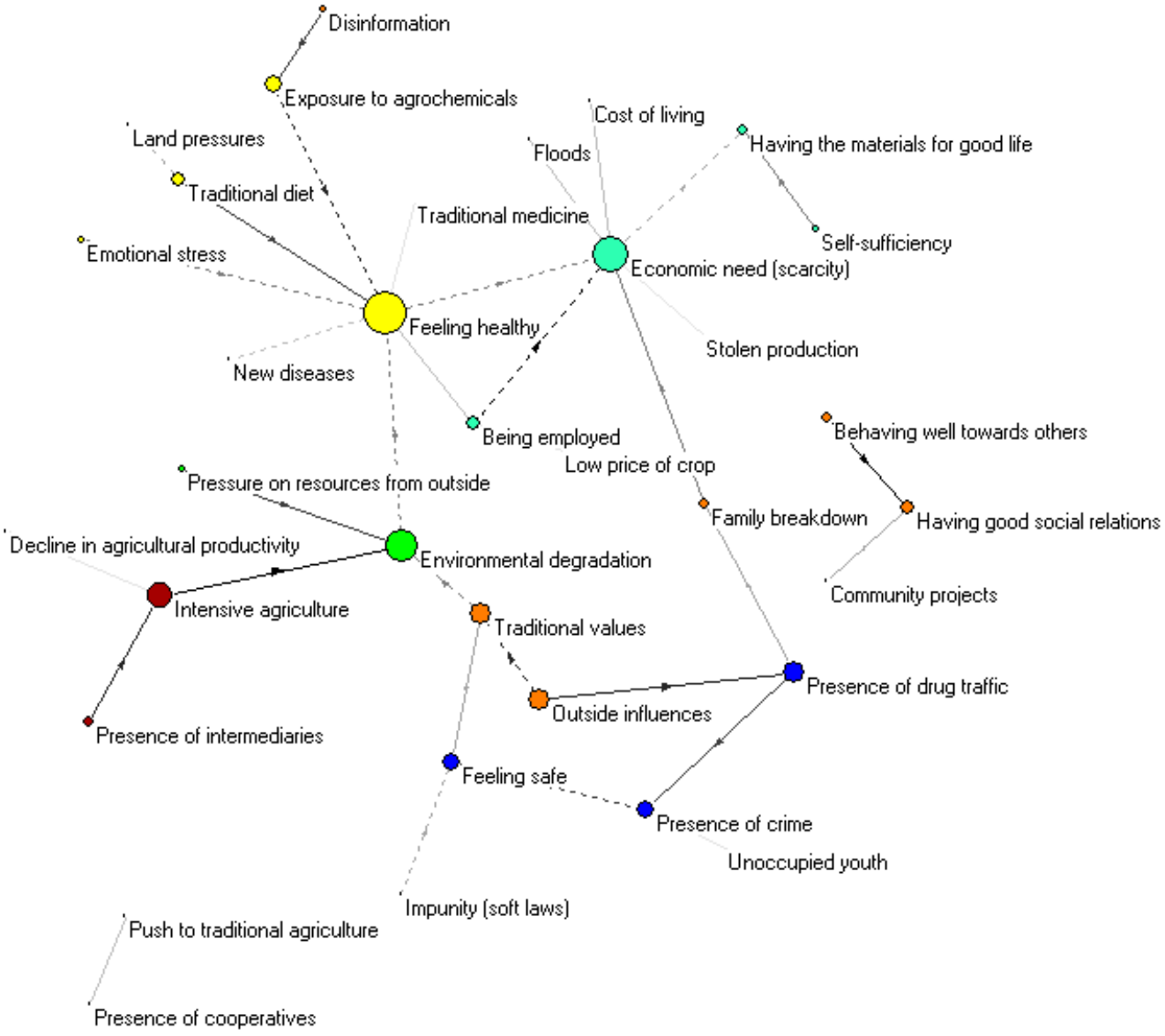


Figure C-18 - *Centrality Index For Factors Affecting The Well-being Of Females From Suretka-Shiroles (n=9)*

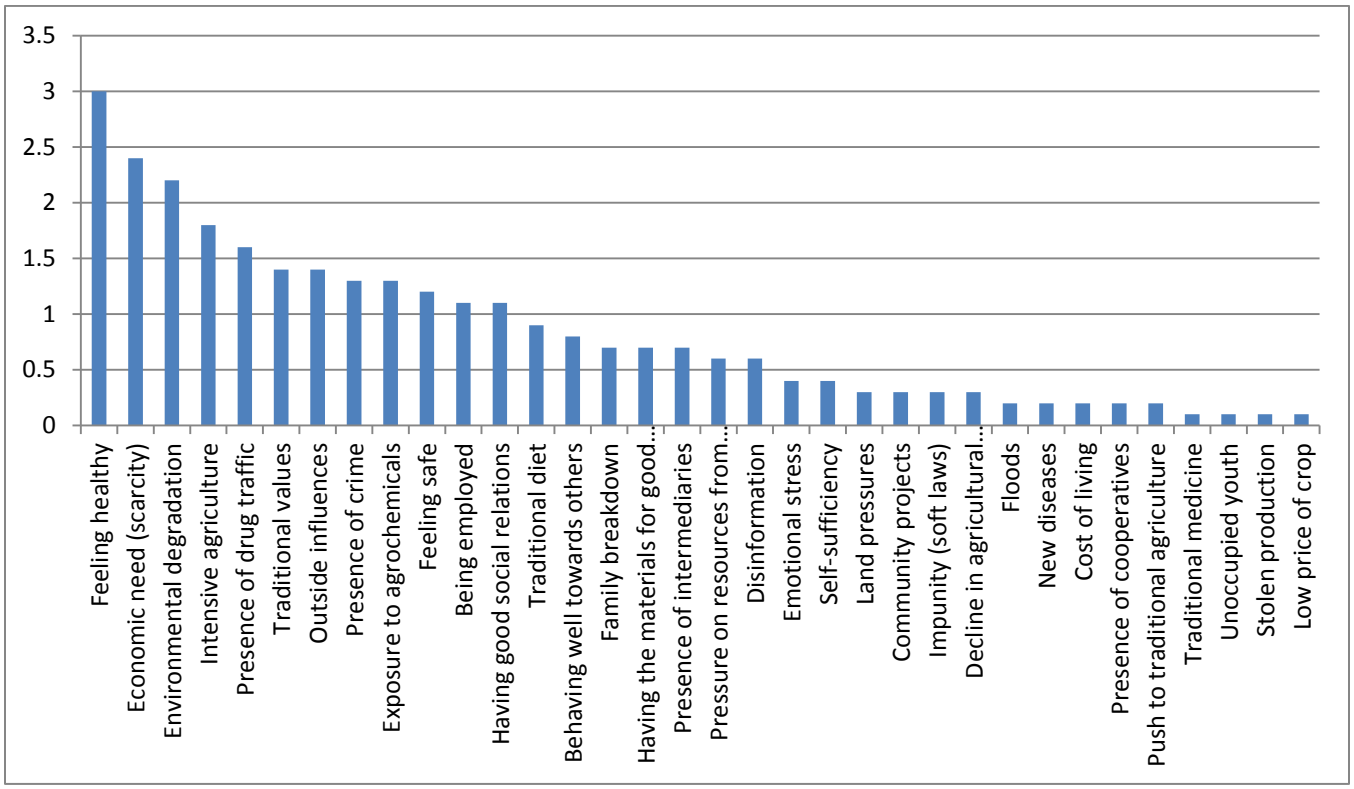


Figure C-19 - *Indegree Index For Factors Affecting The Well-being Of Females In Suretka-Shiroles (n=9)*

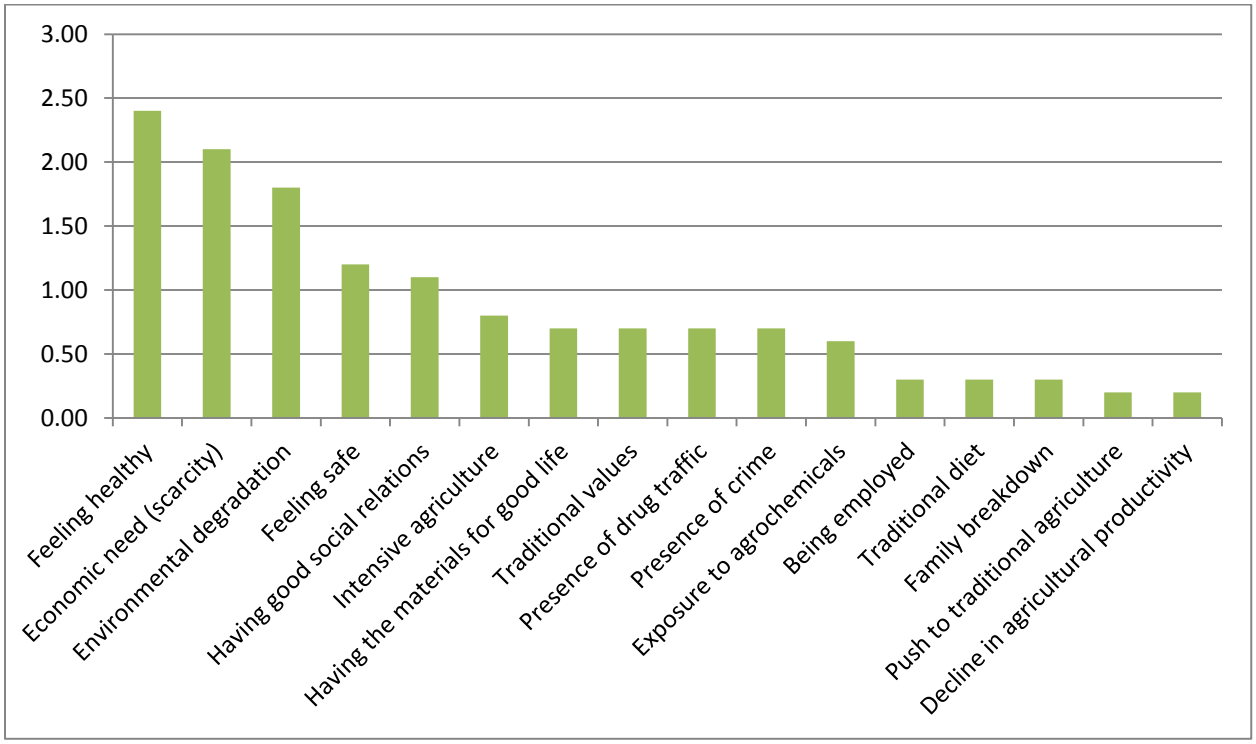


Figure C-20 - *Outdegree Index For Factors Affecting The Well-being Of Females In Suretka-Shiroles (n=9)*

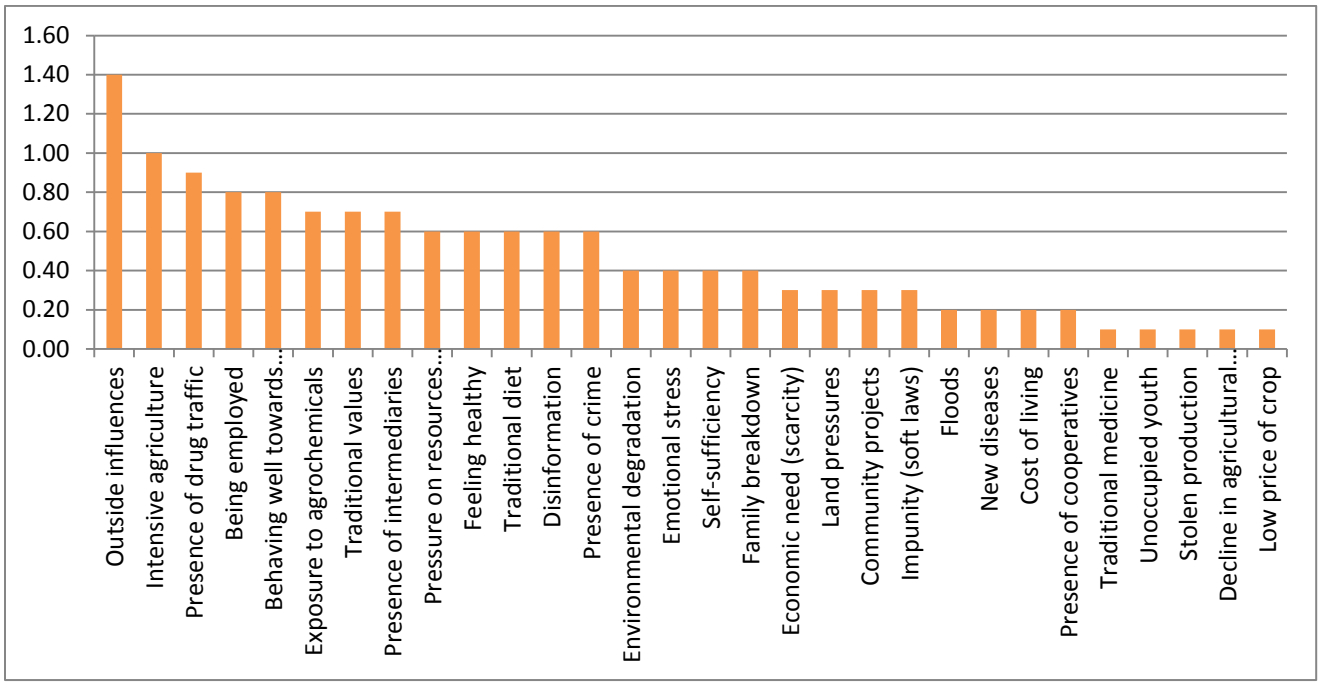


Table C-5 - *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Females In Suretka-Shiroles (n=9)*

Concepts	Centrality	Outdegree	Indegree
Behaving well towards others	0.80	0.80	0.00
Being employed	1.10	0.80	0.30
Community projects	0.30	0.30	0.00
Cost of living	0.20	0.20	0.00
Decline in agricultural productivity	0.30	0.10	0.20
Disinformation	0.60	0.60	0.00
Economic need (scarcity)	2.40	0.30	2.10
Emotional stress	0.40	0.40	0.00
Environmental degradation	2.20	0.40	1.80
Exposure to agrochemicals	1.30	0.70	0.60
Family breakdown	0.70	0.40	0.30
Feeling healthy	3.00	0.60	2.40
Feeling safe	1.20	0.00	1.20
Floods	0.20	0.20	0.00
Having good social relations	1.10	0.00	1.10
Having the materials for good life	0.70	0.00	0.70
Impunity (soft laws)	0.30	0.30	0.00
Intensive agriculture	1.80	1.00	0.80
Land pressures	0.30	0.30	0.00
Low price of crop	0.10	0.10	0.00
New diseases	0.20	0.20	0.00
Outside influences	1.40	1.40	0.00
Presence of cooperatives	0.20	0.20	0.00
Presence of crime	1.30	0.60	0.70
Presence of drug traffic	1.60	0.90	0.70
Presence of intermediaries	0.70	0.70	0.00
Pressure on resources from outside	0.60	0.60	0.00
Push to traditional agriculture	0.20	0.00	0.20
Self-sufficiency	0.40	0.40	0.00
Stolen production	0.10	0.10	0.00
Traditional diet	0.90	0.60	0.30
Traditional medicine	0.10	0.10	0.00
Traditional values	1.40	0.70	0.70
Unoccupied youth	0.10	0.10	0.00

BRIBRI INDIGENOUS TERRITORY MALES FROM SURETKA-SHIROLES

Figure C-21 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Males in Suretka-Shiroles (n=10). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

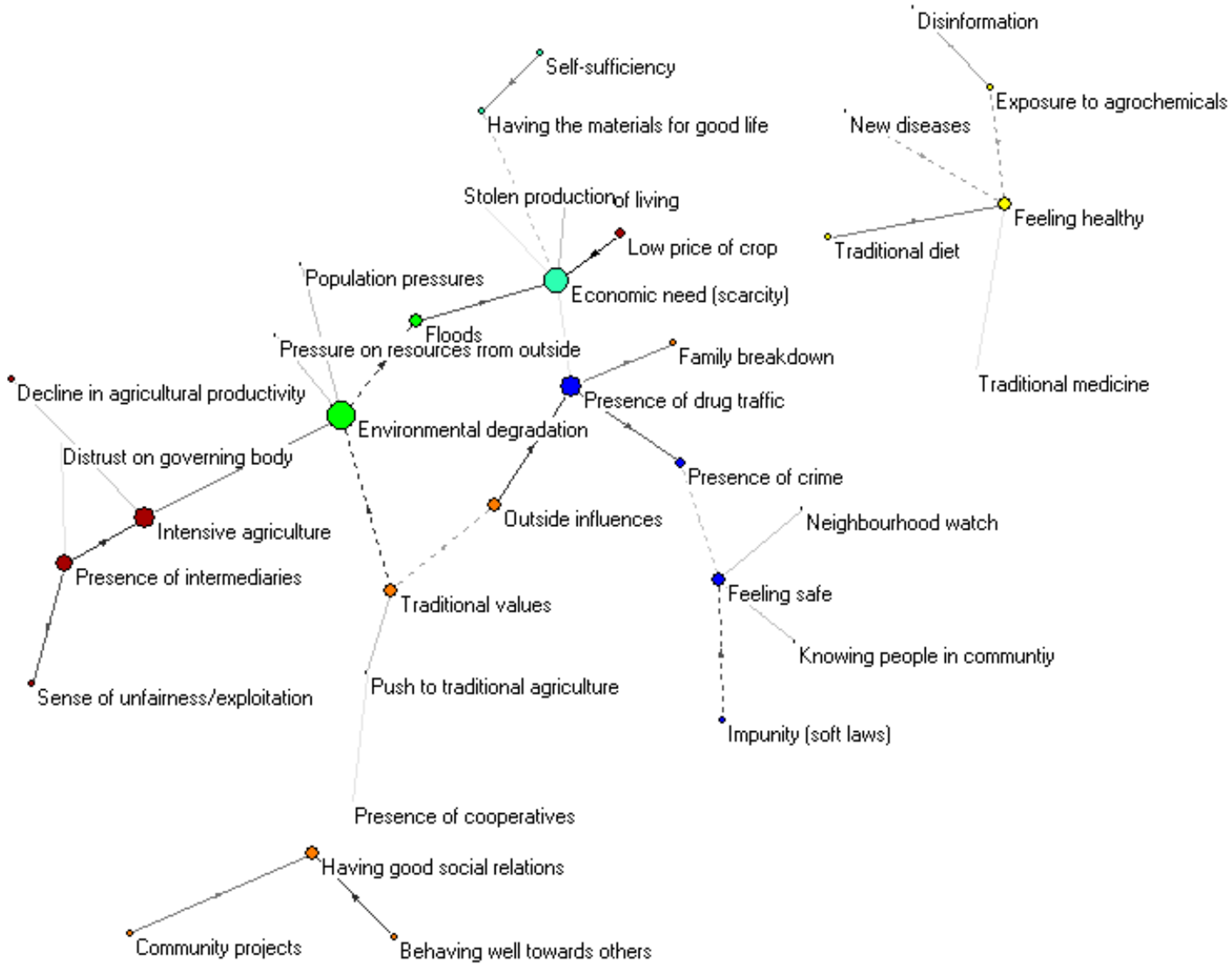


Figure C-22 - *Centrality Index For Factors Affecting The Well-being Of Males From Suretka-Shiroles (n=10)*

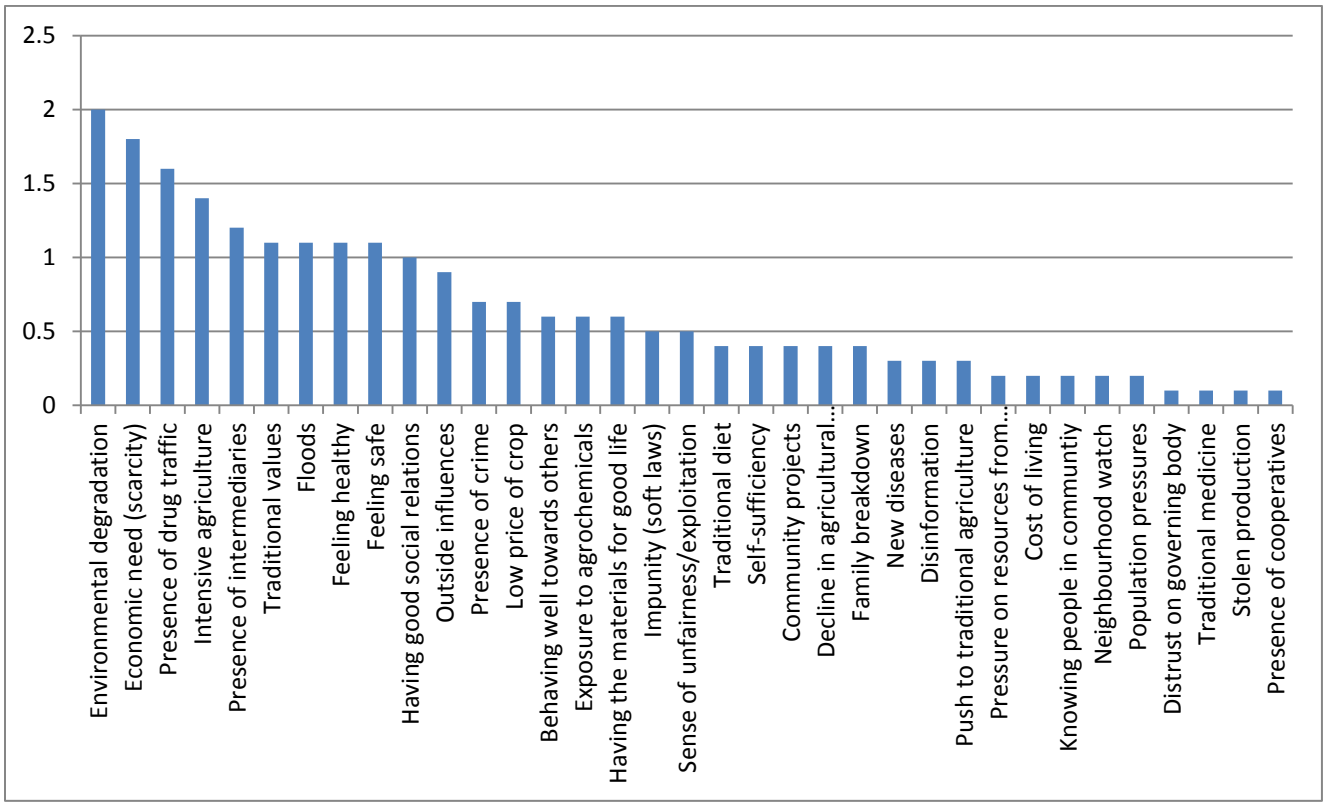


FIGURE C-23 - *Indegree Index For Factors Affecting The Well-being Of Males From Suretka-Shiroles (n=10)*

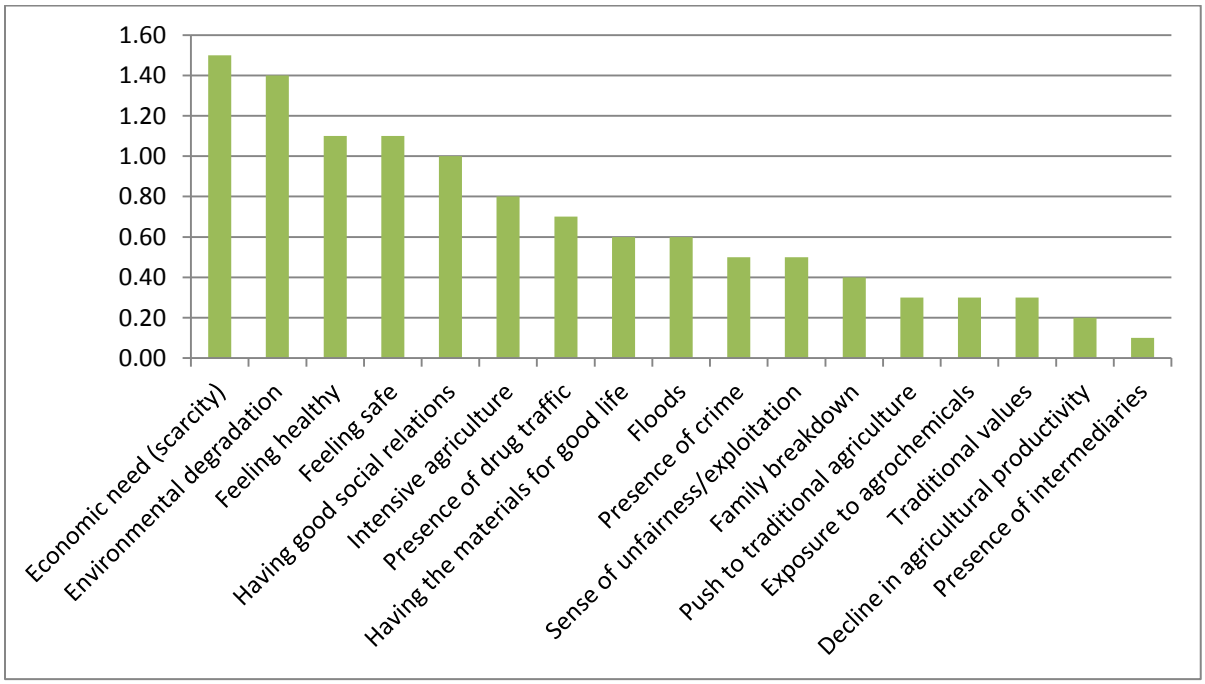


Figure C-24 - *Outdegree Index For Factors Affecting The Well-being Of Males From Suretka-Shiroles (n=10)*

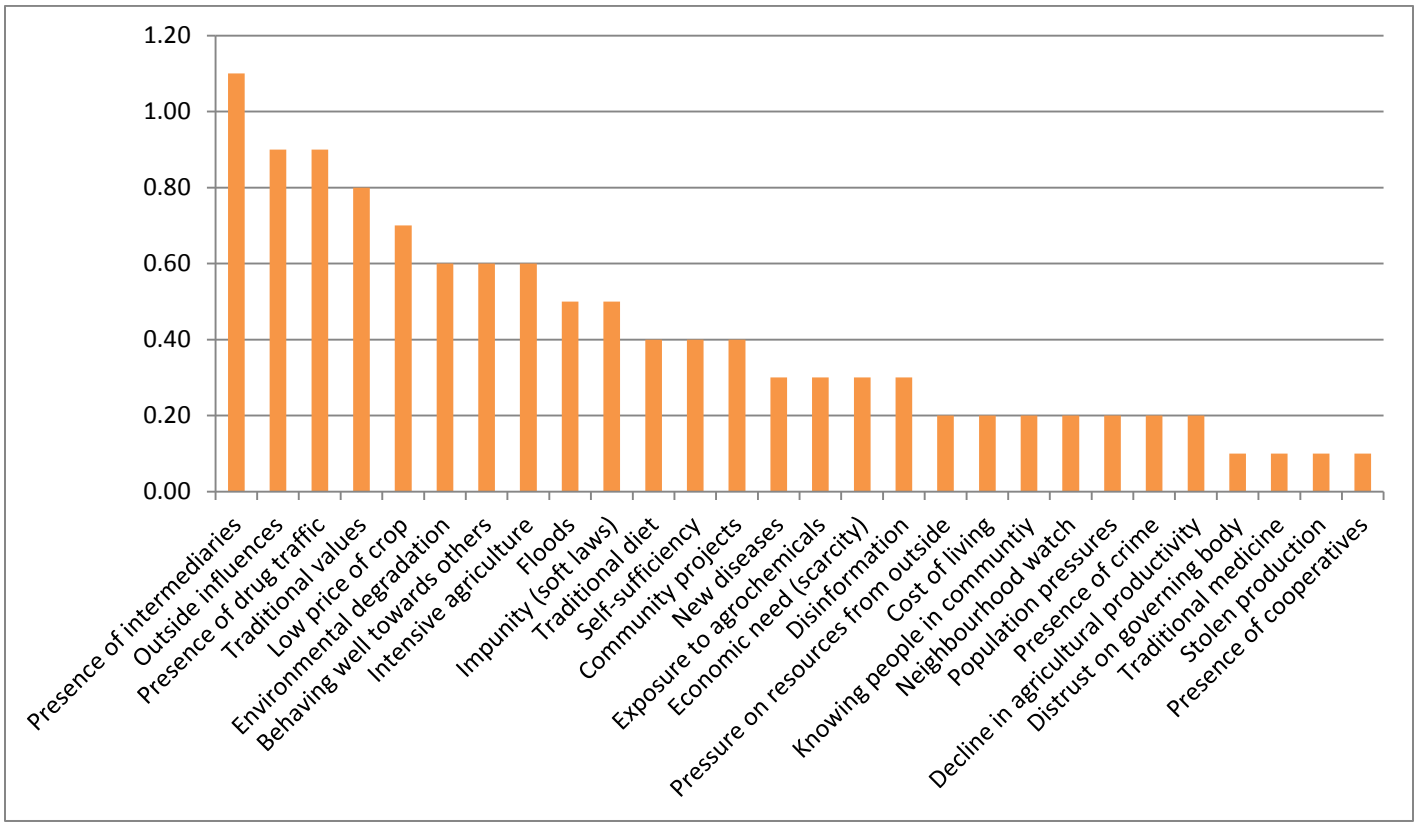


Table C-5 - *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Males In Suretka-Shiroles (n=10)*

Concepts	Centrality	Outdegree	Indegree
Behaving well towards others	0.60	0.60	0.00
Community projects	0.40	0.40	0.00
Cost of living	0.20	0.20	0.00
Decline in agricultural productivity	0.40	0.20	0.20
Disinformation	0.30	0.30	0.00
Distrust on governing body	0.10	0.10	0.00
Economic need (scarcity)	1.80	0.30	1.50
Environmental degradation	2.00	0.60	1.40
Exposure to agrochemicals	0.60	0.30	0.30
Family breakdown	0.40	0.00	0.40
Feeling healthy	1.10	0.00	1.10
Feeling safe	1.10	0.00	1.10
Floods	1.10	0.50	0.60
Having good social relations	1.00	0.00	1.00
Having the materials for good life	0.60	0.00	0.60
Impunity (soft laws)	0.50	0.50	0.00
Intensive agriculture	1.40	0.60	0.80
Knowing people in community	0.20	0.20	0.00
Low price of crop	0.70	0.70	0.00
Neighbourhood watch	0.20	0.20	0.00
New diseases	0.30	0.30	0.00
Outside influences	0.90	0.90	0.00
Population pressures	0.20	0.20	0.00
Presence of cooperatives	0.10	0.10	0.00
Presence of crime	0.70	0.20	0.50
Presence of drug traffic	1.60	0.90	0.70
Presence of intermediaries	1.20	1.10	0.10
Pressure on resources from outside	0.20	0.20	0.00
Push to traditional agriculture	0.30	0.00	0.30
Self-sufficiency	0.40	0.40	0.00
Sense of unfairness/exploitation	0.50	0.00	0.50
Stolen production	0.10	0.10	0.00
Traditional diet	0.40	0.40	0.00
Traditional medicine	0.10	0.10	0.00
Traditional values	1.10	0.80	0.30

BRIBRI INDIGENOUS TERRITORY FEMALES FROM AMUBRE

Figure C-25 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Females In Amubrë (n=9). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

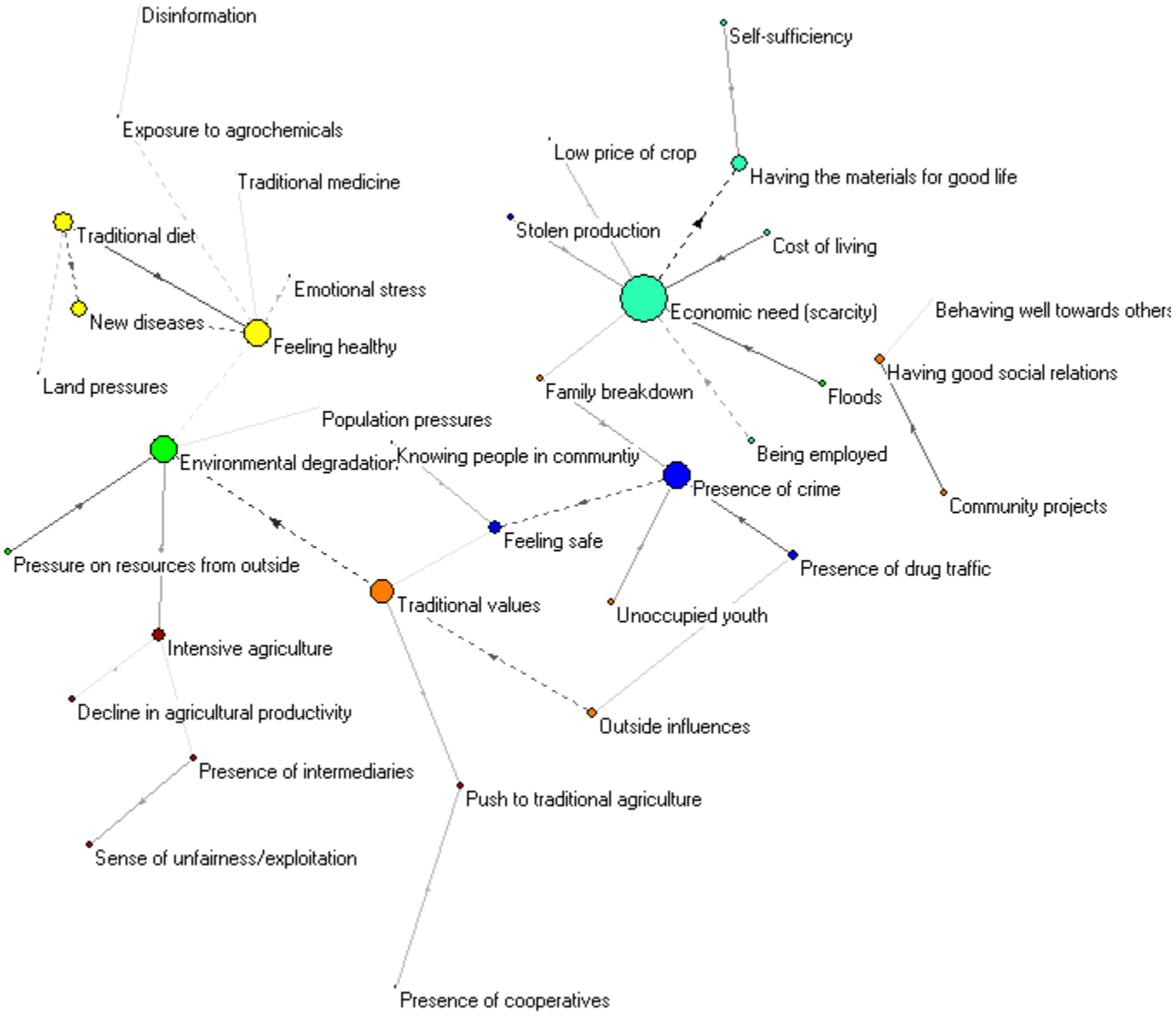


Figure C-26 - *Centrality Index For Factors Affecting The Well-being Of Females From Amubrë (n=9)*

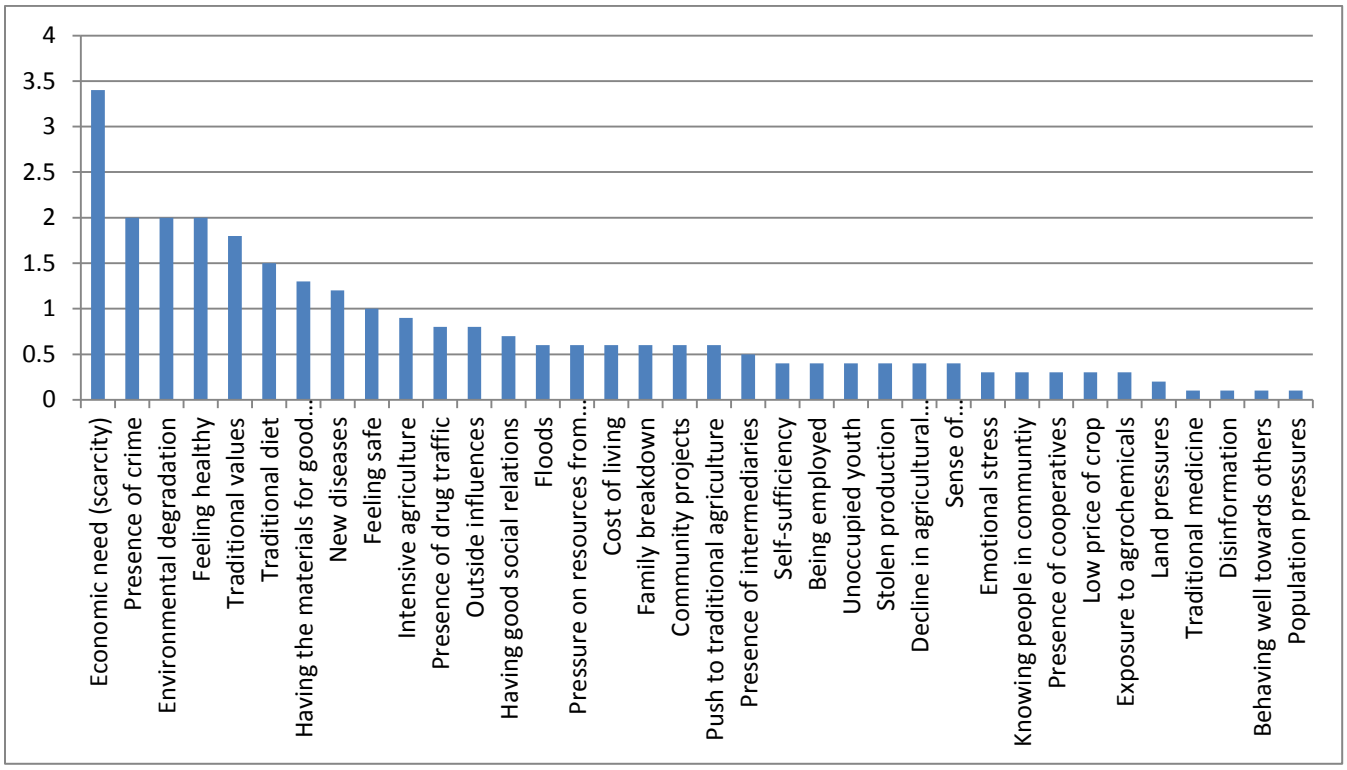


Figure C-27 - *Indegree Index For Factors Affecting The Well-being Of Females From Amubrë (n=9)*

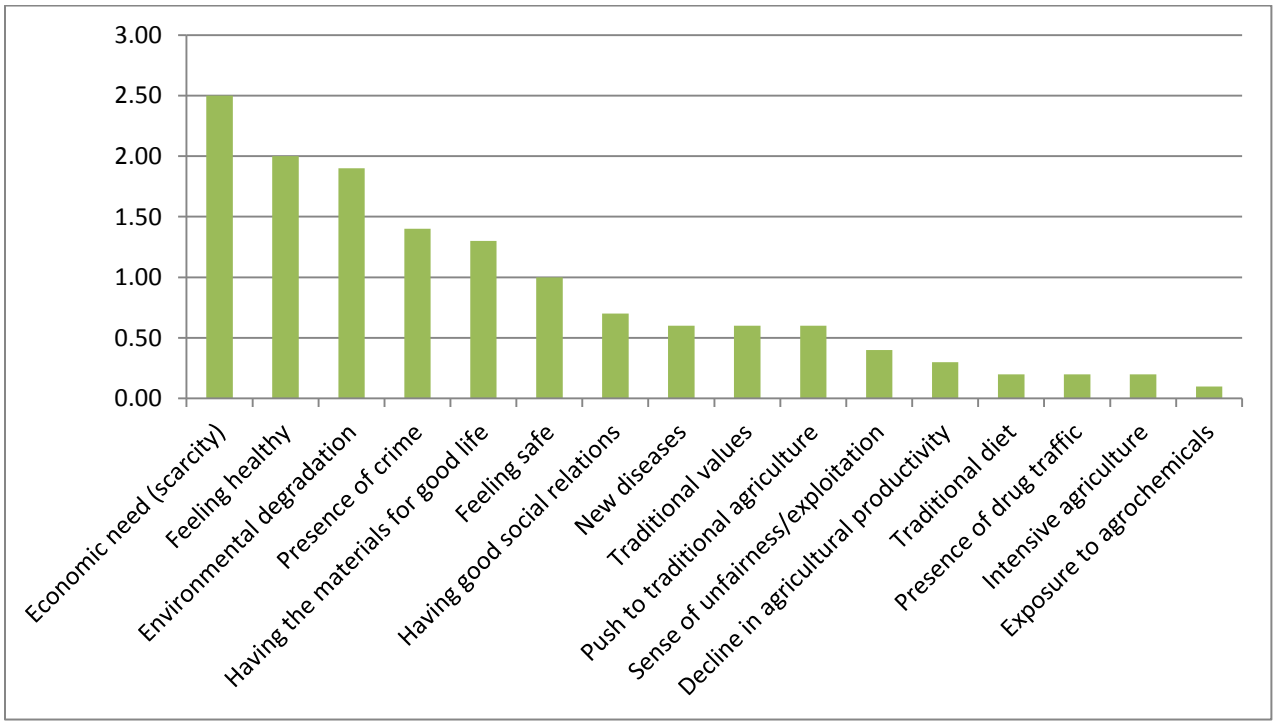


Figure C-28 - *Outdegree Index For Factors Affecting The Well-being Of Females From Amubrë (n=9)*

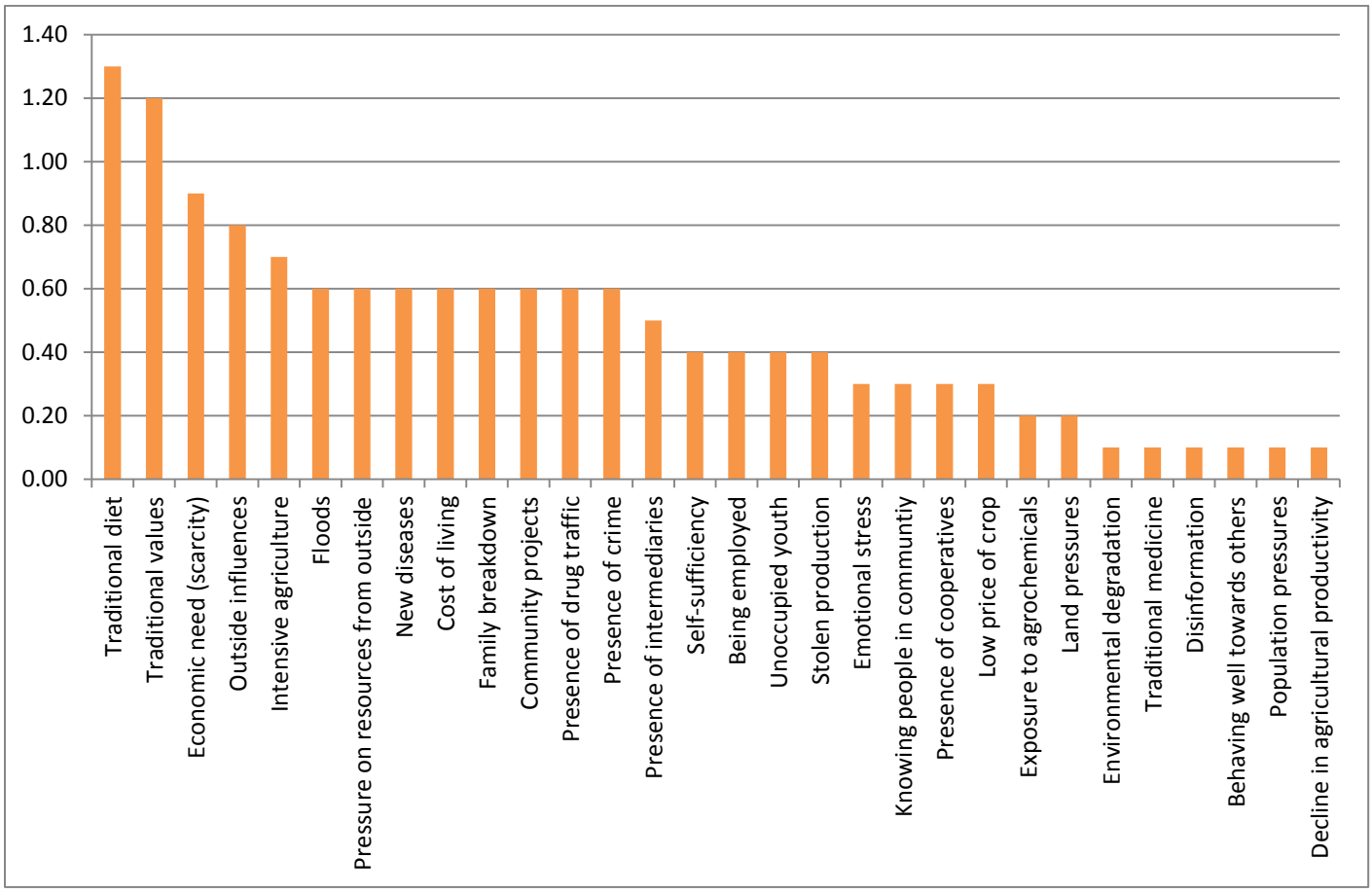


Table C-6- *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Females In Amubrë (n=9)*

Concepts	Centrality	Outdegree	Indegree
Behaving well towards others	0.10	0.10	0.00
Being employed	0.40	0.40	0.00
Community projects	0.60	0.60	0.00
Cost of living	0.60	0.60	0.00
Decline in agricultural productivity	0.40	0.10	0.30
Disinformation	0.10	0.10	0.00
Economic need (scarcity)	3.40	0.90	2.50
Emotional stress	0.30	0.30	0.00
Environmental degradation	2.00	0.10	1.90
Exposure to agrochemicals	0.30	0.20	0.10
Family breakdown	0.60	0.60	0.00
Feeling healthy	2.00	0.00	2.00
Feeling safe	1.00	0.00	1.00
Floods	0.60	0.60	0.00
Having good social relations	0.70	0.00	0.70
Having the materials for good life	1.30	0.00	1.30
Intensive agriculture	0.90	0.70	0.20
Knowing people in community	0.30	0.30	0.00
Land pressures	0.20	0.20	0.00
Low price of crop	0.30	0.30	0.00
New diseases	1.20	0.60	0.60
Outside influences	0.80	0.80	0.00
Population pressures	0.10	0.10	0.00
Presence of cooperatives	0.30	0.30	0.00
Presence of crime	2.00	0.60	1.40
Presence of drug traffic	0.80	0.60	0.20
Presence of intermediaries	0.50	0.50	0.00
Pressure on resources from outside	0.60	0.60	0.00
Push to traditional agriculture	0.60	0.00	0.60
Self-sufficiency	0.40	0.40	0.00
Sense of unfairness/exploitation	0.40	0.00	0.40
Stolen production	0.40	0.40	0.00
Traditional diet	1.50	1.30	0.20
Traditional medicine	0.10	0.10	0.00
Traditional values	1.80	1.20	0.60
Unoccupied youth	0.40	0.40	0.00

BRIBRI INDIGENOUS TERRITORY MALES FROM AMUBRE

Figure C-29 - *Fuzzy Cognitive Map Representing The Factors That Impact The Well-being Of Males In Amubre (n=9). The Size of the Nodes Indicates the Centrality (the bigger, the higher the centrality). The Colour of the nodes Indicates The Dimension Of Human Well-Being More Closely Associated With That Factor (Yellow Is Health, Dark Blue Is Safety, Green Is Environment, Turquoise Is Material Well-Being, Orange Is Social Relations. Brown is Governance). Solid lines Indicate A Direct Relationship Between Two nodes, Whereas Broken Lines Indicate An Inverse Relationship. Darker Arrows Indicate A Stronger Link, Grey Arrows Indicate A Weaker Link.*

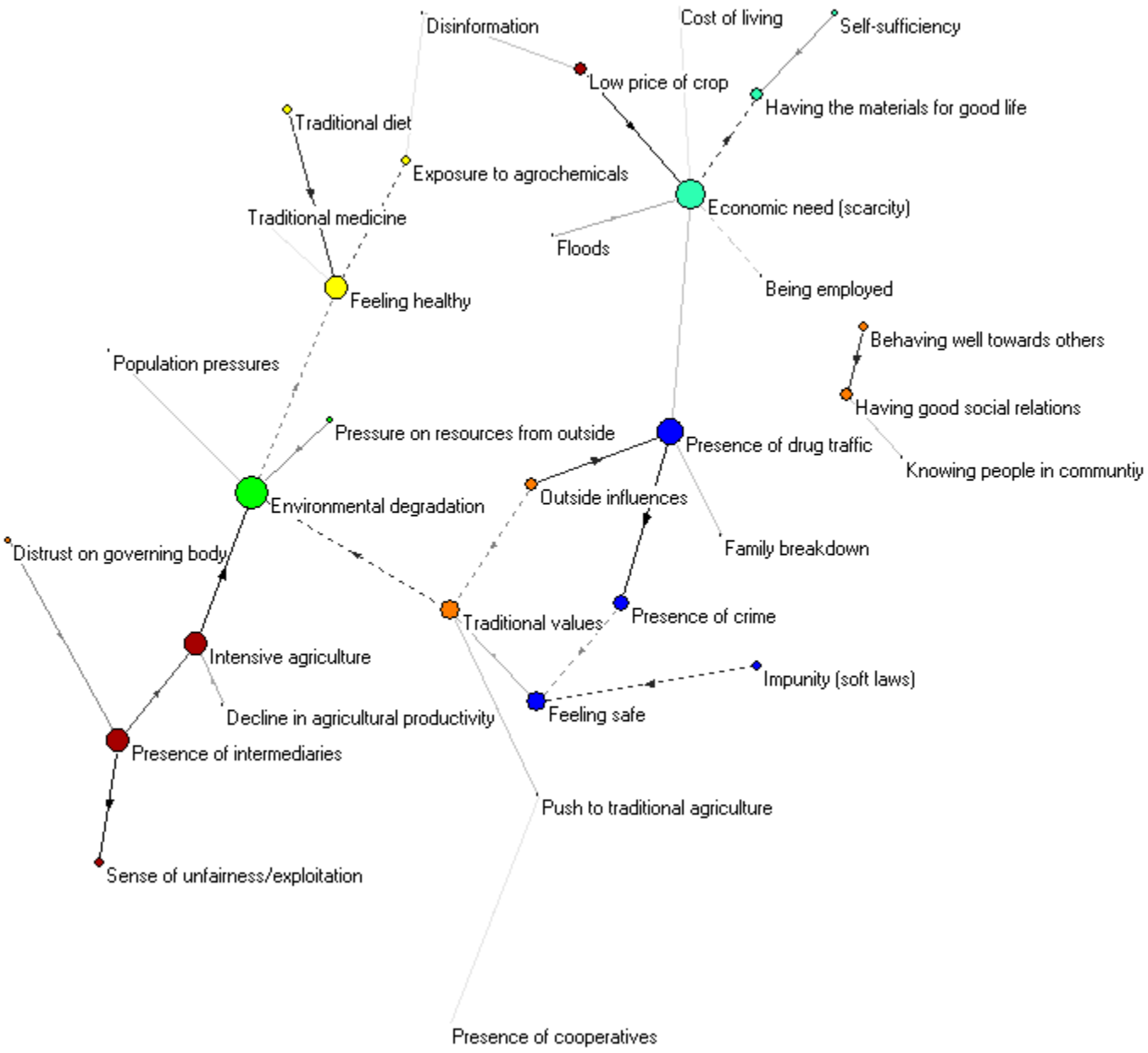


Figure C-30 - *Centrality Index For Factors Affecting The Well-being Of Males From Amubrë (n=9)*

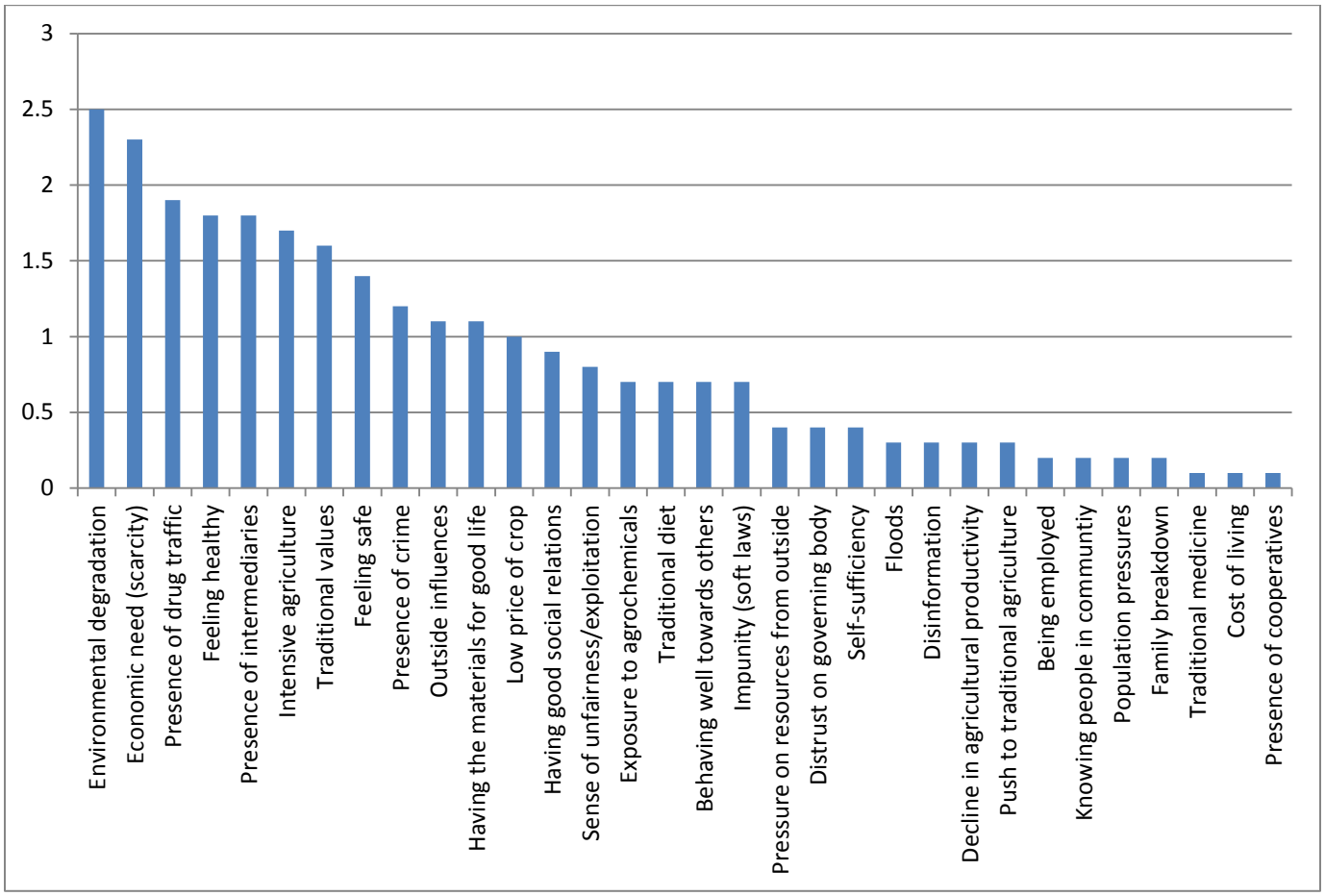


Figure C-31- *Indegree Index For Factors Affecting The Well-being Of Males From Amubrë (n=9)*

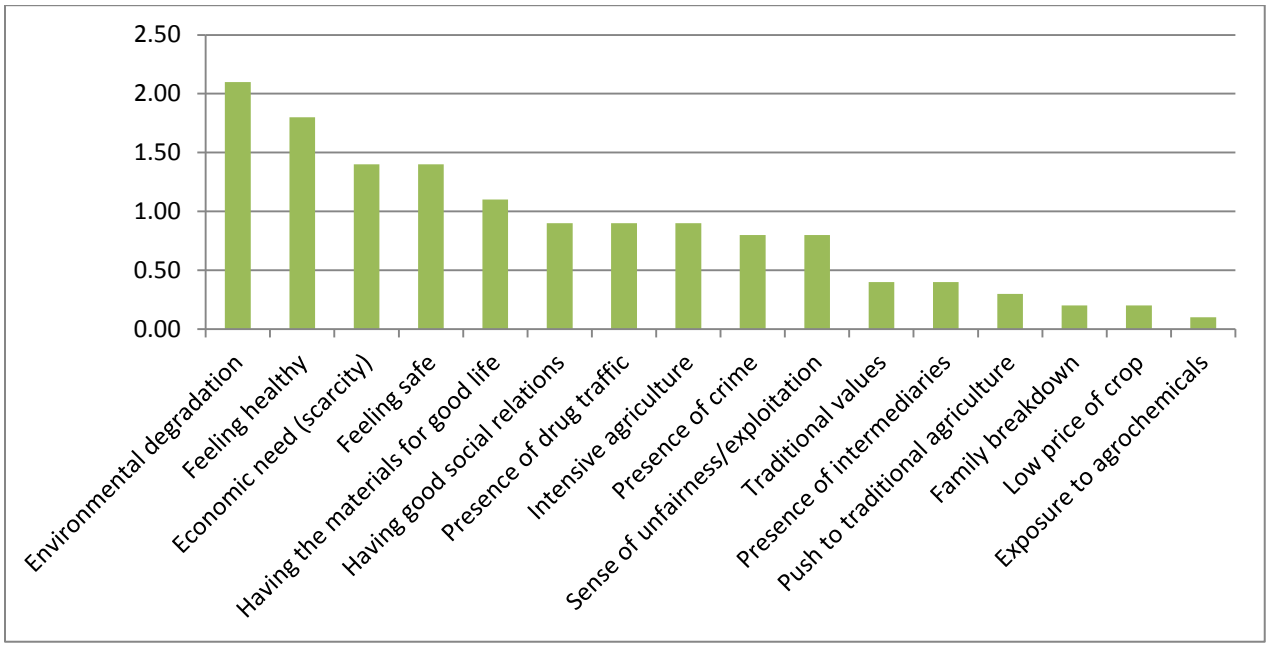


Figure C-32 - *Outdegree Index For Factors Affecting The Well-being Of Males From Amubrë (n=9)*

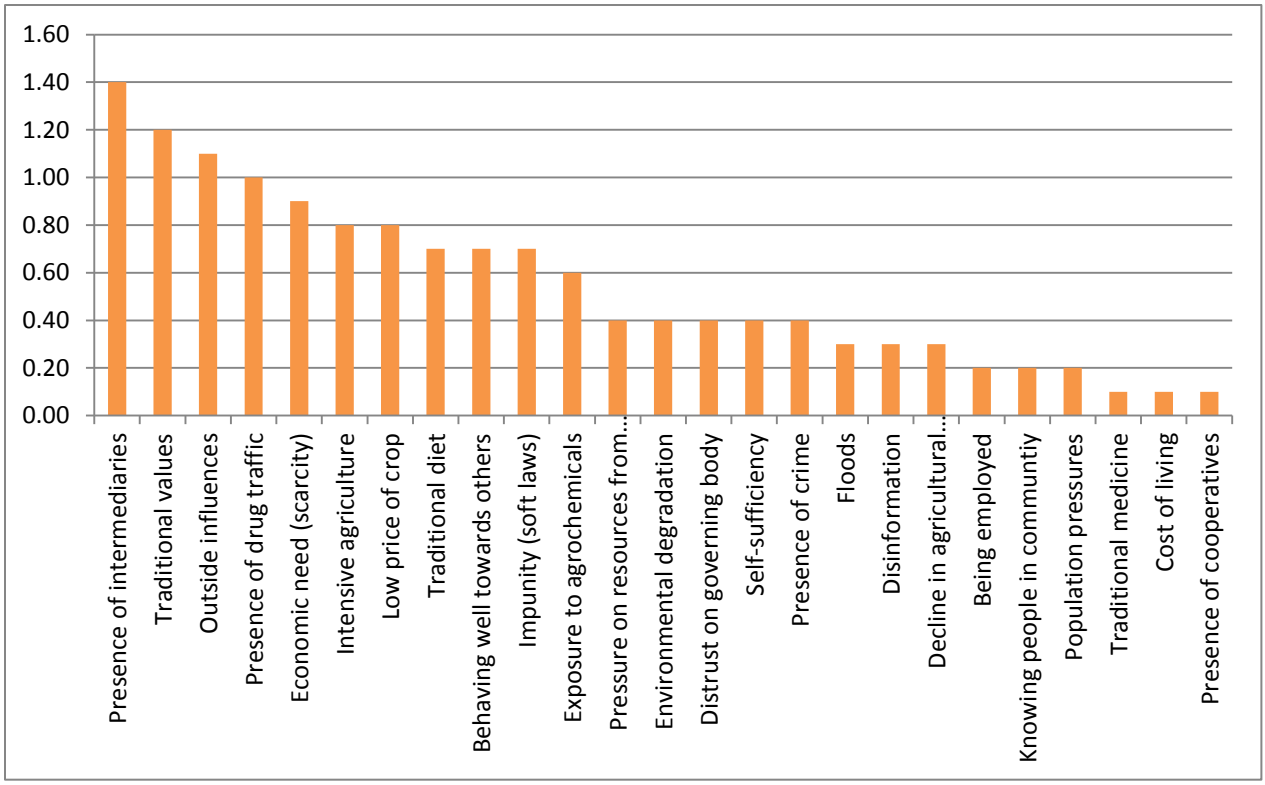


Table C-7 - *Centrality, Indegree And Outdegree Indexes For Factors Affecting The Well-being Of Males In Amubrë (n=9)*

Concepts	Centrality	Outdegree	Indegree
Behaving well towards others	0.70	0.70	0.00
Being employed	0.20	0.20	0.00
Cost of living	0.10	0.10	0.00
Decline in agricultural productivity	0.30	0.30	0.00
Disinformation	0.30	0.30	0.00
Distrust on governing body	0.40	0.40	0.00
Economic need (scarcity)	2.30	0.90	1.40
Environmental degradation	2.50	0.40	2.10
Exposure to agrochemicals	0.70	0.60	0.10
Family breakdown	0.20	0.00	0.20
Feeling healthy	1.80	0.00	1.80
Feeling safe	1.40	0.00	1.40
Floods	0.30	0.30	0.00
Having good social relations	0.90	0.00	0.90
Having the materials for good life	1.10	0.00	1.10
Impunity (soft laws)	0.70	0.70	0.00
Intensive agriculture	1.70	0.80	0.90
Knowing people in community	0.20	0.20	0.00
Low price of crop	1.00	0.80	0.20
Outside influences	1.10	1.10	0.00
Population pressures	0.20	0.20	0.00
Presence of cooperatives	0.10	0.10	0.00
Presence of crime	1.20	0.40	0.80
Presence of drug traffic	1.90	1.00	0.90
Presence of intermediaries	1.80	1.40	0.40
Pressure on resources from outside	0.40	0.40	0.00
Push to traditional agriculture	0.30	0.00	0.30
Self-sufficiency	0.40	0.40	0.00
Sense of unfairness/exploitation	0.80	0.00	0.80
Traditional diet	0.70	0.70	0.00
Traditional medicine	0.10	0.10	0.00
Traditional values	1.60	1.20	0.40